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ATOMIC SHIPBUILDING PROGRAM

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EIGHTY-SIXTH CONGRESS

FIRST SESSION

FEBRUARY 17 AND 18, 1959

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ATOMIC SHIPBUILDING PROGRAM

TUESDAY, FEBRUARY 17, 1959

HOUSE OF REPRESENTATIVES,
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
Washington, D.C.

The committee met at 10 a.m., pursuant to notice, in room 219, Old House Office Building, Hon. Herbert C. Bonner (chairman) presiding.

The CHAIRMAN. The committee will come to order.

The hearing today is to receive testimony from the Department of Commerce, the Maritime Administration and the Atomic Energy Commission concerning the status of the atomic shipbuilding project and other matters looking toward the orderly development of an economic and efficient nuclear merchant marine.

Nearly 4 years ago legislation was introduced to authorize the world's first nuclear-powered merchant ship. This committee took prompt action, and emphasized the importance of producing a ship as practical and advanced as possible in the current state of nuclear know-how. This ship, the NS *Savannah*, is presently under construction at New York Shipbuilding Co. in Camden, N.J. Its keel was laid last May. It will be launched sometime early this summer, and is presently scheduled for completion and delivery early next year.

The Chair has become concerned that progress in the development of the use of atomic energy in ocean shipping in the United States may not be as positive and advanced as it should be. Accordingly, on December 15 of last year I directed an inquiry to Hon. Lewis L. Strauss, the Secretary of Commerce, expressing my concern and requesting a report on—

(*a*) The present status of the nuclear shipbuilding project;

(*b*) The status of plans for future advancement;

(*c*) Waterborne uses of nuclear energy which have not yet reached the planning state; and

(*d*) Recommendations for a long-range program looking toward the orderly development of an economic and efficient nuclear merchant marine.

My letter to Secretary Strauss and his reply are before each member, together with a copy of remarks made by the Chair at the keel-laying ceremony last year, which I believe sum up the problems which we are facing in this new field.

We have with us today Hon. John J. Allen, Jr., Under Secretary of Commerce for Transportation, a distinguished former Member of the House of Representatives and certainly one of the leading members of this committee during the past several Congresses.

It was with regret that the Chair lost his service and assistance on this committee for he certainly played a prominent part in the affairs of the committee and in the working of the committee both in the committee room and on the floor of the House.

It was with personal regret that I saw him leave Congress.

We have with us also the Honorable John A. McCone, Chairman of the Atomic Energy Commission; Hon. Clarence G. Morse, Federal Maritime Administrator; Mr. Richard Godwin, in charge of the nuclear shipbuilding project, and other officials of the two departments. Following the formal statements presented by the representatives of the Department of Commerce and the Atomic Energy Commission there will be presented a briefing through slides and motion pictures covering the progress on the construction of the *Savannah* and other pertinent information.

Mr. Tollefson, do you have any statement you would like to make before the committee proceeds?

Mr. TOLLEFSON. Mr. Chairman, I had not prepared any statement but I certainly do want to join with you in the comments you made with respect to Mr. Allen, who sat alongside of me for some 12 years and I certainly regretted the loss to this committee when he left. He is before us this morning so that we might put him on the spot if we like.

The CHAIRMAN. Mr. Allen will be dealt with very gently in the proceedings of this committee.

Our first witness will be Mr. Allen, Under Secretary of Commerce.

STATEMENT OF HON. JOHN J. ALLEN, JR., UNDER SECRETARY OF COMMERCE FOR TRANSPORTATION

Mr. ALLEN. Mr. Chairman and members of the committee, it is a great pleasure to come back to this room. I spent 12 of the most delightful years of my life here with some of the finest associations that a man can have. I am only glad that I did not lose them entirely and I am still able from time to time to come back. I appreciate the remarks about the good advice of the past years and, as I said to you before, I will not hesitate any more to continue to give the advice but I am not sure that it will be as acceptable as it was in the other capacity. We will try to make it both good and factual.

Mr. Chairman and members of the committee, I appreciate this opportunity to appear before you and present a report on the present status and prospective plans of the Department of Commerce in the field of nuclear-powered merchant ship development and construction.

The Secretary of Commerce has advised your chairman that other matters will prevent him from appearing today, and he has requested that I express his regrets to your committee. I trust that I, together with Mr. Morse, the Maritime Administrator, and Mr. Richard Godwin, Chief of our Maritime Nuclear Projects Office, will be able to acquaint you and the members of this committee with the facts and the plans of our activities in the field of nuclear power as applied to oceangoing commercial vessels. It is my understanding that officials of the Atomic Energy Commission will also advise you concerning the progress in this field.

As you know, this committee was the initiator in the Congress of the legislation under which the Department, through the Maritime

Administration, and in conjunction with the Atomic Energy Commission, is constructing the NS *Savannah*. Congress and the President called for a speedy development and construction of a merchant vessel to prove the practicability of joining a nuclear powerplant with an oceangoing merchant hull to demonstrate the possibility of peacetime use of nuclear power on the ocean lanes of transport and communication between the nations of the world.

The type of vessel selected, as you know, was a combination passenger-cargo type. The vessel will be approximately 595 feet in length 78 feet in beam, and draw about 29 feet of water. It will carry approximately 60 passengers, have a cargo capacity in excess of 9,000 tons, and a service speed of 21 knots. The vessel will have a 20,000-horsepower pressurized water reactor of advanced design. The NS *Savannah* will be launched this summer, and its design and construction will be completed in a period of 39 months from the date of contractual commitment for the powerplant. Mr. Morse will inform you in greater detail concerning the progress of construction and the estimated date for delivery.

An operator has been selected for the NS *Savannah* and training for the deck and engineering officers is well underway. Plans and preparations for shore facilities are being developed. The new ship will be subjected to extensive tests and trials to prove her reliability and then it is planned that she will visit major U.S. ports. During this period the *Savannah* will be employed in limited commercial service by the general agent and thus advance step by step into normal commercial operation.

Although the NS *Savannah*, as the first nuclear-powered merchant ship, will prove the feasibility of the application of atomic power to commercial shipping, it was not contemplated that it would be competitive to build or operate. Instead, it was believed that experience would be gained in the actual construction, operation, legal, and regulatory areas to enable the introduction of other nuclear ships which would more nearly approach the economic status of conventional ships. The Department has, therefore, through the Maritime Administration and in conjunction with the Atomic Energy Commission, undertaken engineering and economic studies for the purpose of determining the type of vessel and reactor system offering the greatest promise of closing the economic gap between the NS *Savannah* and conventional merchant ships.

These studies indicate that a 60,000-deadweight-ton tanker, utilizing a boiling water reactor system, offers the greatest potential for early economic competitiveness of nuclear ships with conventional ships built in U.S. yards and operated under American flag. This results from the ability of the tanker to utilize the weight saving of powerplant plus fuel for cargo capacity. Preliminary estimates indicate that such a vessel would cost approximately $30 million.

The Maritime Administration is preparing the preliminary design for such a vessel, and the Atomic Energy Commission has underway the engineering development and preliminary design work required for adapting a boiling water reactor for marine propulsion. The present pace of engineering and design for the boiling water reactor tanker should result in the completion of preliminary designs by July of this year. In other words, we would be prepared to seek proposals

from private industry to complete development, prepare final design, and contract for the construction. Accordingly, if the intervening development work continues to show promise, we will be in a position in mid-1959 to advance into the project stage.

As you know, it is only through the construction and operation of nuclear ships that we can prove research conclusions and actually demonstrate the value of nuclear power in ship-propulsion systems. Therefore, it appears that the next step would be to seek legislation authorizing the construction of such a vessel. However, before taking this step the values to be gained from construction of an uneconomical prototype tanker must be weighed on a priority basis against all other demands for Federal funds.

In submitting a balanced budget to the Congress for the fiscal year 1960, the President said in his message that it would not be possible to satisfy all proposals for Government spending. He also said that both domestic and defense needs required a review of all Government activities as a part of the continuing budgetary process from year to year, and an examination of new programs and proposals with a critical eye. Desirability alone, as he pointed out, is not to be considered a sound criterion for adding to Federal responsibilities.

This Department will follow a course of action consistent with the budget program of the President. After consideration of the proposal to construct a noncompetitive nuclear-powered tanker, we have concluded that it would not be consistent with the budget program to seek, at the present time, legislation authorizing appropriations for the construction of a nuclear-powered ship, desirable as it might be if funds were available. The Department will, in accord with the desire of the President expressed in his budget message, continue research on improved nuclear propulsion of merchant ships.

In addition to our research and development work we have been giving consideration to legislation which would provide for aid to private industry in the development, construction, and operation of privately owned nuclear-powered merchant ships. This would involve cooperative planning between Government and shipping companies interested in taking active part in the construction of nuclear-powered ships of designs and types giving promise of economic efficiency in competitive service. Conferences with such companies have been conducted. There are difficulties in fixing proper standards as to the cooperative sharing of the initial costs of construction of nuclear ships and of the fuel costs of the pioneer ships. We do not, as yet, feel that we can make definite recommendations to the Congress along this line.

The application of nuclear power to ocean transport has broad impact and significance to our future economy. Tremendous pressures will be imposed on our national production, food, and supply capabilities in a world of rapidly expanding population. We are endeavoring to make new advances in technology in a shorter period of time than was previously possible. We, in conjunction with the Atomic Energy Commission, at present are carrying out studies to identify those commercial activities that can be economically pursued on our oceans, but our principal task at present lies in attaining the ability to generate low-cost propulsive and mechanical power. Consequently, we are centering our attention on those applications in

which we can prove out individual nuclear concepts in relatively promising marine commercial operations.

Mr. Morse, with Mr. Godwin and others of the staff, will present to the committee technical details and other information on the NS *Savannah*, and some details as to the proposed tanker and the development programs in progress.

We have a short movie film on the NS *Savannah*, as well as some exhibits of interest.

The staff and Mr. Morse and I are anxious to answer any questions you have and furnish any specific information that may be desired.

The CHAIRMAN. Are there any questions, Mr. Garmatz?

Mr. GARMATZ. I have just one question.

On page 2, Mr. Allen, the second paragraph, you say:

> An operator has been selected for the NS *Savannah* and training for the deck and engineering officers is well underway. Plans and preparations for shore facilities are being developed.

I wonder if you can elaborate on those two sentences?

Mr. ALLEN. I doubt that I could elaborate any more on the quotation than the information I learned while sitting on the other side of the table.

Mr. Morse or Mr. Godwin can give the complete details as to just how far every phase has gone ahead.

Mr. GARMATZ. That is all.

The CHAIRMAN. Mr. Tollefson?

Mr. TOLLEFSON. Mr. Allen, at the time that the committee had before it the bill authorizing the construction of the NS *Savannah*, there was testimony, as I recall it, to the effect that during the course of construction of the vessel there might be improvements in the construction of reactors which would reduce the possible cost of a reactor.

What has developed since we have authorized the legislation in that respect?

Mr. ALLEN. Well, once more, the very technical part can be better answered by Mr. Godwin, but my impression is that the cost of the ship, the NS *Savannah*, was around $40 million and that the proposed tanker is around $30 million.

The two ships are not entirely comparable in configuration and design but the tanker is contemplated as 60,000 deadweight tons and is considerably larger than the *Savannah*.

I think the difference in powerplants has been brought down to about $8 million. My recollection is that the powerplant in the *Savannah* was roughly $20 million or $30 million so that during the period the costs have come down considerably. I presume that means fuel costs have come down, but I defer to Mr. Godwin for accurate information.

Mr. TOLLEFSON. Perhaps you would prefer that I ask this of Mr. Godwin.

Do you have any information at all with respect to the nuclear powerplant costs reaching a point where a commercial ship could put in the powerplant and operate economically?

Mr. ALLEN. I participated in a discussion 2 or 3 days ago which indicated that the tanker contemplated would not be competitive if it were put in operation. I received the impression that if fuel costs

went down over a period of years, as they might very well do, then such a tanker could get into operation at a profit before its life had expired. However, at the moment there would not be an economically competitive design available to us.

Mr. TOLLEFSON. My recollection may not be accurate but, as I do recall it, Admiral Rickover testified before our committee with respect to development of a nuclear powerplant and, as I recall, he testified that it would probably be up to 10 years before we could develop a powerplant to put in a ship which would be competitive with standard types of powerplants.

From the information and experience that the Department has had thus far, would you say that that period could be shortened?

Mr. ALLEN. I think it is still a good estimate. I think both Dr. Davis and Admiral Rickover agreed that it would be 5 or 10 or 15 years before a nuclear powered device would be competitive. That, as I remember it, was about 4 or 5 years ago.

I think the estimates are still pretty good.

Mr. TOLLEFSON. I have one or two other questions, if I may, Mr. Allen.

As I understand your testimony, the budget picture is such that the Department is not ready to request legislation for the authorization of a nuclear powered tanker. Would the Department oppose a simple authorization bill?

Mr. ALLEN. I know the Department would not propose one. What we would do if we got one is a bridge that I should like to cross when I come to it. It involves more than just my own personal opinion.

I would see no opportunity so far as the Department is concerned of going ahead on either one we might propose or one that someone else might propose.

Mr. TOLLEFSON. The Department, of course, has been giving thought to this matter and your statement suggests at least that maybe the Department might prefer some authorization legislation to encourage private enterprise to build a nuclear powered tanker on some kind of a subsidized basis.

Mr. ALLEN. No; I do not believe we have contemplated legislation that would subsidize the operator of a tanker of any kind, nuclear or otherwise. I think that the first ship would have to be a prototype to establish the competitiveness, and that later there would be an arrangement of some kind. We have not reached that stage yet.

Mr. TOLLEFSON. The prototype powerplant in the nuclear vessel *Savannah* would provide an experience which could be valuable to private industry in any plans it might have for a nuclear-powered vessel. There is no difference, as far as the powerplant is concerned, whether it is in a cargo vessel or a tanker, is there?

Mr. ALLEN. I would defer to Mr. Godwin or Mr. Morse as to the costs involved. I suppose it is true that the only thing the powerplant does ultimately is to turn the propeller, and then it becomes a case of how cheaply you could do that.

The reactor in the *Savannah* was patterned after the reactor in the *Nautilus*, as I remember it, in order that there might be immediate construction of a reactor that had had some practical use at sea.

The reactor that would be contemplated for the next ship would be a boiling water reactor, which I believe is quite different in its efficiency. I would defer again to the experts.

Mr. TOLLEFSON. I have just a couple of other questions.

You say that when the NS *Savannah* is completed it will first call at major U.S. ports. Is it contemplated that it will be carrying any cargo or passengers when calling at American ports or will this just be a means of showing the vessel to the American people?

Mr. ALLEN. I think the latter, although I have not discussed with anyone the cargoes that would be involved.

The original plan for the *Savannah* was that it should be an exhibition to the world, including ourselves, of a peaceful use of nuclear power and later go into the more nearly commercial operations.

The only exact use I have heard for it has been a request that it show up at the Seattle trade fair and be convenient to Tacoma, I suppose.

Mr. TOLLEFSON. Then after it has called at American ports, during which time it may or may not carry cargo and passengers, it will call at foreign ports. When it calls at foreign ports it will be operated by some agent and then will carry some cargo and some passengers?

Mr. ALLEN. I believe that is the plan, although Mr. Morse can give you the details.

Mr. TOLLEFSON. That is all, Mr. Chairman.

The CHAIRMAN. Now, Mr. Allen, you made reference, on page 4 of your general statement, to the President's budget. I followed you closely there but in reading the President's budget, I want to ask you what the President meant in this statement:

> Research on improved nuclear propulsion of merchant ships is continuing. Legislation should be enacted to assure that nuclear materials may be distributed for use as fuel on U.S. merchant ships.

Now, that, among other things, is the primary reason for these hearings. The President says, "legislation should be enacted."

In your statement, you say you do not think that you are going to send down any proposal and you do not know what attitude the Department would have if something was initiated here in this committee.

Now then, who is going to pay attention to the President's statement here when he said "should"?

I think that is a fair question to ask both of the Department of Commerce and Mr. McCone when he comes up.

If we are going to take the President's budget message seriously and, of course, there has been some question whether it is going to be taken seriously in its entirety or not, but when he makes a positive statement that it should be enacted, this committee wants some guidance to know who is going to pay attention to the President.

Mr. ALLEN. With regard to that statement, I think the problem comes from restrictions which I believe are in the law concerning the use of atomic or nuclear fuels. Under present law, a distribution of fuels cannot be made for purposes which merchant shipping would require that fuels be made for. Once again, I believe it is more a matter for the Atomic Energy Commission side than it is with respect to the building of ships.

Amendatory legislation would be necessary, as I understand the problem, before fuel could be made available for private operators to take into foreign countries as would be the case if shipping were involved.

The CHAIRMAN. Now, Mr. Allen, of course you were very active and enthusiastic about the legislation we heard and reported out of this committee and which the Congress passed for the construction of a nuclear icebreaker. Of all the hearings which have ever been before this committee in my day they were the most interesting.

I understand we are encouraging Canada to go into that field, and we all know that Russia is ready to commission its nuclear icebreaker.

When the whole scientific world is interested in the Arctic and Antarctic, it is difficult for me to understand how the President vetoed the icebreaker legislation and yet makes this statement:

> Research on improved nuclear propulsion of merchant ships is continuing. Legislation should be enacted to assure that nuclear materials may be distributed for use as fuel on U.S. merchant ships.

This committee has spent a lot of time trying to carry forward the directive in the 1936 act with respect to promoting the American merchant marine and it is hard to reconcile these things.

We have this material and we are seeing other nations promote its use in merchant ships perhaps and in other ways perhaps, and it is hard for us to understand the position of the administration.

Where are we going?

Mr. ALLEN. Well, on the first question as to getting our laws in shape so that nuclear fuel could be made available to ships when the ships are available, I think that is a first step. I think that is what the President had in mind as being a first step.

When it comes to building any ship, to quote, "however desirable," the whole question of budgetary requirements against the individual project involved has to be weighed.

In this instance, particularly on the tanker, we came to the conclusion that the budgetary requirements at the present were not sufficient to put the tanker in a prior position to other matters for which money might be spent.

I think that would be the same consideration.

The CHAIRMAN. Do you think the tanker is more desirable than this nuclear icebreaker that would be utilized in many, many fields, for scientific purposes and to many other uses that it could be put to?

Mr. ALLEN. If I were the only one concerned, my personal opinion would be that I would prefer the tanker.

You may remember that when we had the hearings here on the nuclear icebreakers, I was very much impressed, and possibly others in the committee were impressed with the fact that the nuclear icebreaker could remain with power and some comfort in the Arctic Ocean for long periods of time in excess of the period that a conventionally powered icebreaker could remain.

Shortly after that the *Nautilus* went under the icecap, and the capacity for staying in the far north for taking ocean observations of the bottom and doing the oceanography work, one of the abilities that had seemed to me so necessary in the nuclear icebreaker, was performed probably better and quicker and with more facility by the potential work of a submarine under the icecap. That was a personal reaction.

The other uses for a nuclear icebreaker were down in the Antarctic where there is no question but that a nuclear icebreaker, able to stay

in there, might give a better performance than the conventional icebreaker that had to get in and out.

But as between a nuclear icebreaker and a tanker that could ultimately develop into a competitive use of the fuel, it would seem to me as a personal opinion that that tanker would do more for the merchant marine than the icebreaker would.

I recall that from the icebreaking standpoint that Admiral Richmond, who would be the operator of it, opposed its construction. However, he said if anyone was going to have it he did not want anyone to have it except the Coast Guard.

But I would place the practical demonstration of ability for the advantage of the merchant marine with the tanker rather than with the icebreaker.

The CHAIRMAN. So would you say, then, that this question about whether the legislation should be enacted is better answered by Mr. McCone?

Mr. ALLEN. As to the technical progress, and as to when the nuclear device that would propel a tanker would be reaching the economically competitive stage, I think the AEC and Mr. McCone would give the better answer.

The CHAIRMAN. Mrs. Sullivan.

Mrs. SULLIVAN. I have just one question, Mr. Chairman.

Mr. Allen, do you know whether the entire $40 million that was estimated to be needed for the *Savannah* has been approved and appropriated?

Mr. ALLEN. I think it must have. My recollection is that the money for an appropriation of that sort is the full appropriation at the time that the contracts are let, so that the money once appropriated is all available and is kept available. The fact that the launching is planned for this summer and the operation for 1960 would indicate that the project is completely finished to the point of starting operation.

Mrs. SULLIVAN. That is what I wanted to be sure of.

That is all, Mr. Chairman.

The CHAIRMAN. Mr. Ray.

Mr. RAY. I have no questions.

Mr. ZELENKO. Mr. Chairman, may I ask at whose request were these hearings instituted, the Department or the committee?

The CHAIRMAN. The Chair.

Mr. ZELENKO. Further, Mr. Allen, pursuing the chairman's questions to you, I notice on page 4 you quote the President's stand on budgetary requirements and you state:

> **Desirability alone * * * is not to be considered a sound criterion for adding to Federal responsibilities.**

Would you say that the administration's position is that necessity rather than desirability is a criterion for us to proceed?

Mr. ALLEN. It is hard to use someone else's language and fully state the meaning. What it means to me is that we have a certain amount of money, above which it is not desirable to spend. Within the amount available there are many projects, many desirable projects, and some must be eliminated in order to keep within the money.

In the assigning of priorities, we determine the projects that are to go ahead. In the relative scheme of things, we have concluded

that the tanker does not come ahead of some of the other requirements. It would tend to unbalance the budget, which is, of course, in a very precarious state of balance at the moment. Further imbalance would be, in my opinion, and I think in the opinion of the Department and the President, an unwise thing.

Mr. ZELENKO. Then do I understand that the substance of your statement is that if it is the wish of this committee and the Congress that we proceed with legislation to implement the building and operation of an atomic tanker that the administration would turn thumbs down on it for budgetary reasons? Is that what you are trying to tell us?

Mr. ALLEN. If you are looking for the recommendation of the administration on this project, the administration would not approve it or recommend it at this time.

Mr. ZELENKO. Is that your stand right now, the administration's stand?

Mr. ALLEN. Yes; I think it says so almost in those words.

Mr. ZELENKO. Then may I ask you this, sir: What is the purpose of your testimony? Is it to indicate to us now the stand of the administration? If it is, then I do not understand part of your testimony in which you indicate certain desirability with going ahead with this.

As the chairman indicated, it seems to me most inconsistent. I would like some further discussion from you on that subject if you would be good enough to give it to me.

Mr. ALLEN. Well, on the first point, the statement on page 4 is, I think, fairly exact:

> This Department will follow a course of action consistent with the budget program of the President. After consideration of the proposal to construct a noncompetitive nuclear-powered tanker, we have concluded that it would not be consistent with the budget program to seek, at the present time, legislation authorizing appropriations for the construction of a nuclear-powered ship, desirable as it might be if funds were available.

Circumstances can change with regard to the potential competitiveness of the ship as designs for nuclear reactors and fuel costs change.

Mr. ZELENKO. We are not talking of competitiveness now. We are talking at this point of money.

Now, is your Department going ahead with plans on the drafting boards to build one of these tankers, and you say it would be futile work to implement your plan. Is your Department now proceeding with plans?

Mr. ALLEN. The Department has proceeded in the past with designs that would be indicative of the uses that could be made of atomic power, and the combinations of hull and plant that could be utilized. High in the consideration of the Department is the thought that the next step is to arrive at the competitiveness of the ship that comes out as a prototype.

If we can make advances toward the competitiveness without actually building the ship, it would seem to me wise to wait.

Mr. ZELENKO. I would ask you this: How does the question of competitiveness apply? Do you mean competitive on a money basis?

Mr. ALLEN. Yes.

Mr. ZELENKO. Are you not in effect wasting your time now and I do not mean that facetiously or personally; I mean with the Department going ahead and drawing plans and putting them on the drafting

boards, talking about it, and being against it. The talk seems to be in favor of it but the administration, in its stand, seems to be against it.

I know you will agree with me that we should not engage in futile enterprises, we here, and in your Department.

Mr. ALLEN. I think the answer is twofold. The first is whether, standing alone, the building of a tanker immediately would be desirable to accomplish the purpose in mind, part of that purpose being to get a ship that would be competitive with a conventionally powered ship.

The other, if we had determined that we had reached that point, would be whether this project, in the light of all budgetary considerations and the demands of other projects for funds, would get the necessary priority for building.

As to that one, it is our view at the present time that the priority is not there, and that the ship should not be proposed by the Department.

Mr. ZELENKO. I should like to call your attention to the beginning statement on page 4. It seems to me that, in view of your stand, even your research on the drafting board is futile and inconsistent with your testimony.

You state as follows:

> As you know, it is only through the construction and operation of nuclear ships that we can prove research conclusions and actually demonstrate the value of nuclear power in ship propulsion systems.

If you are not going to build a ship like this, how are you going to demonstrate the result of your research? Your research may be an utter waste of time. You, yourself, say you have to build the ships to prove your research. You come here and say the administration is against building the ships for whatever reason. This is a budgetary one.

Can you resolve that inconsistency in your statement if you agree it is an inconsistency?

Mr. ALLEN. I do not think that there is an inconsistency in the statement. I think we can progress in both the design of nuclear plants and toward their economical or competitive operation without actually building a ship. I think that is demonstrated by the fact that the costs have come down since the *Savannah* was first let out to contract.

The other point is that in view of the budgetary considerations we have come to the conclusion that this is not the time to proceed even if the ship is a desirable project.

Mr. ZELENKO. Therefore, sir, I should like to call your attention to the following sentence to the one that I read:

> Therefore, it appears that the next step would be to seek legislation authorizing the construction of such a vessel.

In view of what you just told me, apparently your entire statement is inconsistent.

First you say, in the top sentence, the only way we could prove our research is by the construction of the vessels.

You have just told us, in substance, "Well, it is not necessary to go ahead and build them because we can find out enough by research."

Then you proceed to say we should seek legislation but you also tell us that we do not want legislation because we have not got the money.

Now, is that a fair résumé of your statement, both printed and oral?

Mr. ALLEN. It is not the résumé I would make, Mr. Zelenko.

Mr. ZELENKO. I want to be very fair about it and I want to find out first of all whether or not you mean what you say when you say that the construction and operation of the ships will prove your research.

Mr. ALLEN. When it happens. That is true.

Mr. ZELENKO. Did you mean what you said when you put that in your statement?

Mr. ALLEN. Certainly.

Mr. ZELENKO. That means that the way to prove your research to see whether it is any good is to build the ships?

Mr. GROSS. Would the gentleman yield?

Mr. ZELENKO. I yield.

Mr. GROSS. Perhaps he neglected to add four words: "at a later date."

Mr. ZELENKO. I would go along with the gentleman.

How much longer, 5 years, 10 years?

Mr. ALLEN. I think that the operation of a ship at any time will prove the abilities of that ship.

Now, in this case, I think legislation to authorize the construction of a vessel would be in fairly general terms and, if we want to build a ship at any time, then we should of necessity come in for an authorization bill.

On the other hand, and this is a personal opinion and philosophy, it seems to me that if the Department or the administration brings up a bill asking for authorization, there is some implication that it is ready to go ahead with the entire project and seek the appropriations with which to carry it through.

I would want no implication of such a nature dependent upon the presentation of an authorizing bill, because at the moment we would have no intention of seeking appropriations even though the ship might be desirable.

Mr. MILLER. Would the gentleman yield?

Mr. ZELENKO. I yield.

Mr. MILLER. During the past 10 years, have you ever known the time when you could have said that the building of such a ship was budgetarily feasible?

Mr. ALLEN. I do not know of any time during the last 12 years when the balancing of the budget and the problem of inflation has been so acutely before and so high in the consideration of the administration as it has been in recent months.

Mr. MILLER. You would not say, would you, that the threat of inflation has not been with us over these last 10 years and continuously with us since we have either been at war, under the threat of war, or preparing for war? It is being given a little more emphasis right now but it has always been here. I have always heard the same arguments that the gentleman has, I am sure, about now is not the time to spend money, let us put it off until a later time.

We got into a little snag on that in the case of missiles, did we not? We put off the building of missiles and now we are going into a crash program and spending more money to get them done.

If this is a good thing, should not the prototype ship be built now so that we will know what we are going to do?

Mr. ALLEN. Well, my personal opinion again is, and I would defer to the opinion of those more expert, is that the building of a prototype at this time would not demonstrate enough to make the expenditure justifiable.

Mr. MILLER. Then why are we building the *Savannah*?

Mr. ALLEN. To get the initial proof of feasibility of operation and to get some experience.

Mr. MILLER. Is it not time that we get experience in other ships? I am certain the gentleman is conscious of the fact that right now there is some sort of conference being held to protect our supply of oil coming into this country. I know a lot of material came into all of our offices just the other day on that.

Do you not think this is a pretty good time to start in in determining whether we can have such a ship or not?

Mr. ALLEN. Well, as I have said, I think that what could be demonstrated by the operation of such a ship would not give it a priority over other things.

Mr. ZELENKO. Mr. Secretary, just to sum up your stand, you say that you can prove your research by operation.

The next step should be legislation authorizing the construction of a vessel.

You then say that we have not got the money and we should not go ahead with legislation, so, to sum up your stand, you are against any legislation to build an atomic tanker.

Is that the stand of the administration at this time?

Mr. ALLEN. The stand of the Department of Commerce is that it does not intend at this time to propose legislation to authorize the building of a tanker.

Mr. ZELENKO. Well, that is the Department's stand that it does not propose. Now, to propose is not to answer my question, are you against it? The proposal may be by a number of people and you may be for it. In other words, I would like to get an unequivocal stand at this time. Are you against this legislation or are you for it regardless of who it is proposed by?

Mr. ALLEN. I will meet that one when I come to it.

Mr. ZELENKO. You are at it now.

Mr. ALLEN. Well, I am going to stick by the answer in the statement, which I think is unequivocal.

Mr. ZELENKO. Well, I do not understand that too well and I would appreciate it if you could tell me whether or not the Department and the administration is against legislation at this time to build an atomic tanker. Is it for it or against it?

Mr. ALLEN. We are against proposing it ourselves at this time, and I think without question, and this once more is a personal opinion, we would be against an appropriation at this time if such legislation were passed.

Mr. ZELENKO. Are you against authorizing legislation? That is what I want to know. We do not deal with appropriations here. We deal with authorization.

Are you against any legislation authorizing this vessel at this time? When I say "you," I do not mean you personally; I mean the administration and your Department.

Mr. ALLEN. Well, I have to give you a personal response because the discussions that I know of have not reached the point where I can give a Department position with respect to a bill before the bill comes to the Department.

As a personal view, we are against proposing legislation at this time. We would, to be consistent with that view, not have an easy time approving a bill that comes from other sources under the present budgetary situation.

Mr. ZELENKO. I yield to Mr. Garmatz.

Mr. GARMATZ. Mr. Allen, I am not trying to put words into your mouth, but does this not give part of the answer that the gentleman has been seeking:

> However, before taking this step the values to be gained from construction of an uneconomical prototype tanker must be weighed on a priority basis against all other demands for Federal funds.

That is part of it.

Again I say I am not trying to put words in your mouth, but does that not answer part of the gentleman's question?

Mr. ALLEN. That is exactly right. We are concerned not only with the project, which in itself might be desirable, but also with the overall budgetary program.

Mr. GARMATZ. The demand for Federal funds on a priority basis.

Mr. ALLEN. That is exactly right.

Mr. ZELENKO. I have just one more question.

What do you consider in your Department, maritimewise, of prior necessity to this project? That may help.

Mr. ALLEN. Well, I think the financing of the current programs in the conventional ships is one of the prior things.

I would put that ahead of other maritime considerations.

Mr. ZELENKO. I have one more question.

In the last Congress, we enacted legislation providing for appropriations for the building of two merchant vessels in both the Atlantic and Pacific.

We find now, in reading the budget message, that the President is asking that we retract that legislation.

Does your consideration in your statement involving priorities also involve retracting or recalling that legislation for the appropriations for the two vessels?

Mr. ALLEN. I do not know of any move to repeal that legislation.

Mr. ZELENKO. It was suggested by the President that it be repealed.

Mr. GLENN. Will the gentleman yield?

Mr. ZELENKO. I yield.

Mr. GLENN. I do not think he said that in so many words. He said he thought we should reconsider.

Mr. ZELENKO. That is the same thing.

Mr. GLENN. I do not think so. Reconsider on the financing of it.

Mr. ZELENKO. I will just wind up my questioning by asking this: Do you think that any proposed legislation on your part regarding this particular project is anticipatory by 5 years, 10 years, 1 year? What is your idea?

I want to know whether we are going to waste our time. We do not want to pass legislation and have it vetoed.

On the other hand, if it is a good thing and you are against it, we want you to take the credit for it.

Mr. ALLEN. From our standpoint, it would seem to me that when we arrive at the conclusion that the priority for a nuclear-powered tanker and the state of the art are such that it would be advantageous to go ahead, we would recommend not only a bill but the financing for it. Until then, we will not recommend either.

Mr. ZELENKO. Would that take place, let us say, if we enact legislation and the people of the United States seem to be for it. Following public opinion at that point might the administration change its mind or is it a firm statement now that they are against it regardless of what public opinion is? In other words, is it strictly money or is it publicity?

Mr. ALLEN. I think you are asking me a question on which I cannot go beyond my personal opinion.

Mr. ZELENKO. Thank you.

The CHAIRMAN. Mr. Mailliard?

Mr. MAILLIARD. I have no questions.

Mr. CHAIRMAN. Mr. Ray?

Mr. RAY. I have no questions.

The CHAIRMAN. Mr. Pelly?

Mr. PELLY. Thank you, Mr. Chairman.

Mr. Allen, in establishing this priority for a tanker am I right in assuming that you had conferences with the Department of the Navy in order to get their views on it as against maybe an icebreaker or any other type of nuclear-propelled vessel?

Mr. ALLEN. Very frankly, Mr. Pelly, the views of any Department are coordinated pretty much through the office of the Bureau of the Budget, and the priorities were pretty well determined well in advance of the time that I went down there this year. I am quite sure that the needs of the Defense Department, as well as the other needs, were all taken into consideration in arriving at the recommendations of the budget.

Mr. PELLY. Out of your experience, would you think there is some reason to suggest that, if there were a nuclear-propelled tanker constructed that it should be built by the Navy or that it should be operated by the Navy?

Mr. ALLEN. Well, my observation over the years comes from the other side of the desk, and my personal opinion is that the transport of cargo, such as fuel and dry stores, from point to point can be taken care of as well or better by the merchant marine than by the military ships. I would say that the decision would depend on the purpose for which the tanker was desired.

If it were desired to run with the fleet and engage in high-speed operations for fueling at sea, I would think it would be the Navy's ship.

If it were to carry cargoes, particularly large cargoes from point to point, I would prefer a merchant ship operation.

Mr. PELLY. When you get into these highly subsidized operations, and very costly ones as experimental for research, sometimes we overlook those costs if its defense features are emphasized and I wondered if we would be quibbling over dollars if it were in the Navy construction budget.

Mr. ALLEN. I doubt that we would if the priority were given to the project.

Mr. PELLY. I would certainly personally be interested in knowing what the views of the Navy are as to the desirability of a nuclear tanker. Maybe we could get that from a later witness.

Meanwhile, I certainly would like to say, Mr. Chairman, that it is certainly a great pleasure to have Secretary Allen here, and I think he has made a very fine statement.

The CHAIRMAN. Mr. Lennon?

Mr. LENNON. I have no questions.

The CHAIRMAN. Mr. Gross?

Mr. GROSS. Mr. Chairman.

Mr. ALLEN. I am pleased that the administration has taken the position that it has on the building of a highly expensive nuclear propelled tanker. I hope that some day it will take the same position on a highly expensive icebreaker. In this room we are all aware of the fact, I am sure, that this budget is balanced on paper and on paper only. We are not going to get the revenues asked for by way of postal rate increases. We are not going to get the increase in gasoline tax that is necessary to balance the budget.

As you have suggested, it is precarious, it is balanced on paper only. Only last week the Government had difficulty in refinancing a $9 billion issue of matured securities and that on the basis of offering 3¾ to 4 percent interest on the securities they were trying to refinance.

It is high time that we stopped any unnecessary spending.

That is all.

The CHAIRMAN. Mr. Oliver.

Mr. OLIVER. No, Mr. Chairman, I have no questions.

The CHAIRMAN. Mr. Flynn.

Mr. FLYNN. I have no questions.

The CHAIRMAN. Mr. Curtin.

Mr. CURTIN. Mr. Allen, since the *Savannah* and the proposed nuclear powered tanker would both be surface vessels, what can you learn with an experimental tanker as to the fuel power of nuclear power than you cannot learn with the experimental *Savannah?*

Mr. ALLEN. I would defer to Mr. Morse and Mr. Godwin on that. I think Mr. Godwin will indicate that the progress in design and conception of the ship would be primarily toward making it competitive with conventional powered ships both as to size and length of run. There was no such concept in the design of the *Savannah.*

Mr. CURTIN. You think, then, that the design of the vessel itself has changed radically since the *Savannah* was laid down?

Mr. ALLEN. Yes, it is 60,000 deadweight tons against I suppose 20,000. It is a ship which would have cargo carrying space proportionate to the tremendous size of the ship all in the holds since the engine space is relatively small. This is different from the *Savannah* with its accommodations for 60 passengers.

Mr. PELLY. Would the gentleman yield?

Mr. CURTIN. Surely.

Mr. PELLY. I wonder if the gentleman would ask that question as against the nuclear powered aircraft carrier. Is not that 60,000 tons?

Mr. ALLEN. I am afraid you are out of my field now.

On the aircraft carrier, there is a difference in that it is highly essential that the ship should stay at sea for very long periods, which is not the case with the point-to-point cargo carrying ship.

Mr. PELLY. Are they both of the same design, boiling water reactors; that is, the carrier and the tanker?

Mr. ALLEN. That I do not know.

Mr. CURTIN. Mr. Allen, the length of time they could stay at sea would not be conditioned on the fuel plant, would it, because with a nuclear powerplant they could stay at sea indefinitely. Would there not be other factors like food, storage space, crew accommodations, and so forth?

Mr. ALLEN. The aircraft carrier has to stay at sea. The tanker can go in. The tanker, because of its ability to go in at each end of the run has to compete with conventional types of propulsion, but the ship that stays at sea does not attempt to compete with that type of propulsion.

Mr. CURTIN. My thought was that the reactor is going to be the same regardless of the time that the ship is going to stay at sea.

Mr. ALLEN. That is not technically true, but it is true.

The CHAIRMAN. Mr. Casey.

Mr. CASEY. Mr. Allen, I would like to pursue a little more the chairman's thought on why you picked out a tanker and abandoned the idea of the icebreaker. Is it the idea of the Department to concentrate on commercial uses rather than other benefits, such as the scientific uses?

Mr. ALLEN. Yes. As far as the merchant marine is concerned, the policy statement charges the Department with fostering an American merchant marine as a vehicle for carrying the domestic and foreign commerce and as an auxiliary to the military departments in time of war, and the function of the Department is largely commerce. Because of that, the activities of the Maritime Commission have been devoted first toward proving that a ship could be designed and propelled by nuclear power, which is the case with the *Savannah*, and then to try to design a ship that would begin to be a competitive ship.

Now, in the handling of oil by tanker, you have, I suppose, the best example of a ship that can be very large and carry cargo, the cost of each unit of which would be less because of the great bulk carried. You would have operations which would keep the ship at sea and using its powerplant 60, 70, or 80 percent of the time, as against 50 percent or less with another dry cargo ship. All the economic breaks that could come between two ships, one propelled by nuclear power and one by conventional power, would be available to the testing of the nuclear powered ship.

Mr. CASEY. Now speaking just on this question of priorities and the budget, you say that this, in your opinion, is a low priority proposition; that is, it is lower than anything that is considered in the budget.

Mr. ALLEN. It is lower than something that got the money.

Mr. CASEY. That is right.

Now, then, recently there has been considerable talk of our lagging in oceanography and in fact that was quite a story in the local papers here, a front page story.

As I understand it, the United States had one ship that is more or less obsolete. Do you not think that the icebreaker could be utilized in this oceanography that seems so important as well as for experimental purposes with reference to the economical operation of a nuclear-powered ship of the type that you propose for a tanker?

Mr. ALLEN. Well, I think we get into a little different field of comparing alternatives. The new ship that is being built for the Coast and Geodetic Survey service will give them a very much needed ship for oceanography and other purposes. But it would be my opinion, which is not expert, that a conventional type ship for oceanography studies would do the work that any nuclear-powered vessel could do at a much cheaper cost in probably all circumstances with the possible exception of observations at the South Pole.

The CHAIRMAN. Let me say, about getting into the subject of oceanography, that the National Academy of Sciences approached the chairman of this committee and wanted to be heard. They came only on Friday and released a report Saturday, so that the Chair did not have an opportunity to give the matter the consideration that certainly it is entitled to. I have just talked to the minority member of the committee, Mr. Tollefson, and this committee will hear the subcommittee that was set up by the National Academy of Sciences on this subject of oceanography, because most of the operating agencies that would go into this field would come under the jurisdiction of this committee.

I want to move along so that we can hear Mr. McCone.

Are you finished, Mr. Casey?

Mr. CASEY. I have no further questions, Mr. Chairman.

The CHAIRMAN. Mr. Glenn.

Mr. GLENN. I have no questions, Mr. Chairman.

The CHAIRMAN. Mr. Downing, I overlooked you.

Mr. DOWNING. I have no questions.

The CHAIRMAN. Mr. Hoffman.

Mr. HOFFMAN. I have no questions.

The CHAIRMAN. Mr. Johnson.

Mr. JOHNSON. Mr. Chairman.

Mr. Secretary, you put great stress on the fact that this project is not consistent with the budget program of the President. How much stress do you put on the administration's position that private industry should enter the picture in the development and construction of these powered merchant ships?

Mr. ALLEN. Very great stress. The objective is to build a prototype ship that will demonstrate that it is competitive with conventional power so that private operators can undertake the operation of a fleet of ships that is competitive, whether it is nuclear powered or conventionally powered, with the hope that the nuclear power will be in such state that they can do so.

Mr. JOHNSON. What legislation would prove necessary to aid private industry in this picture?

Mr. ALLEN. At the time that we conclude that the prototype ship is competitive and can be built and should be built, then legislation authorizing its building and its operation would be necessary.

Mr. JOHNSON. I think you stated that you have had, I think, conferences with the shipping companies in respect to some cooperative planning between Government and these companies.

Mr. ALLEN. Those were not personal conferences. I believe Mr. Morse can probably give you most of that.

Mr. JOHNSON. I see.

I have no further questions.

The CHAIRMAN. Mr. Miller.

Mr. MILLER. Mr. Allen, I was out of the room when my turn came and I want to welcome you here as an old colleague from Alameda County and a former member of this committee. I know your interest in this field.

I am concerned, as I know you are personally, with the fact that this ship is being given a low priority. I am concerned with the fact that the matter has been introduced here that we are going to withdraw the insistence on building the two new ships that we authorized last year when you were so active. Have you any idea when prototype ships or other ships in the merchant marine will ever be given a high priority?

Since I have been on this committee, we have always been told that there was always some priority over and above. Now, when can we expect to get a high priority for those things that go to make for an active, modern merchant marine?

I do not have to labor the fact with you that our replacement program is behind schedule. Yet when we try to replace it, you say, again, "Low priority." When are we going to get the merchant marine back in the place where it belongs and get it on a priority with some of the other departments or other functions of our economy?

Mr. ALLEN. That is a hard question to answer, as you know.

The CHAIRMAN. The committee asked that the Secretary of Commerce be present today. In a letter he directed to the chairman he stated that, due to certain reasons, he could not be here. In all probability that is a fairer question to ask the Secretary of Commerce who, I imagine, establishes policy in the Cabinet to see what his interests and his aggressiveness toward this subject might be.

Mr. MILLER. I would accept the chairman's statement.

Inasmuch as he cannot be here, he has sent his Deputy Secretary here, and certainly the relationship between the Secretary and the Deputy Secretary are such that the Deputy Secretary in the absence of the Secretary can speak for the Department of Commerce.

The CHAIRMAN. That was why he was sent here.

Mr. MILLER. That is right. So that I am not going to accede to your request.

Mr. ALLEN. Mr. Chairman, I would like to give a partial answer.

The most difficult job that I have before me comes out of provisions in the budget message calling for an overall consideration of the transportation policy of the Federal Government and then a second very specific injunction to give attention to the problems of the merchant marine.

Those two studies will be toward the development of some policy that will not only be sufficient but can be implemented.

I think I have said to the chairman over the years that we ought to take a look at the 1936 act because, in my opinion as a member of this committee, it seemed somewhat difficult to accept the operation of the act as being sufficient when we would see that a third of the ships only were in good financial condition and on the other hand we were carrying only 14, 15, or 18 percent of our foreign commerce. So that I think the whole problem is one which is high in my own consideration of what is important, and either fortunately or unfortunately, I have the whole job put on my shoulders.

Mr. MILLER. I think that I can appreciate and sympathize with the gentleman, but this is the thing that worries me. We have recently

taken the operation of the commercial air out from under the Secretary of Commerce effectively in setting up the FAA. All of the operations now find themselves in a special bureau where they can go directly to the President. The railroads and the trucks have been under the ICC, a special agency of Government that can assure them of hearings in the high places. We repeal laws and grant railroads special privileges.

Perhaps we should look to pulling the maritime activities of Government out from the Department of Commerce where they are lost in a maze of other things and set up a special agency of Government that will allow it to go directly to the President or come directly to the Congress without having to balance the moneys allocated to the Department of Commerce, with 20 other agencies? Is that not where trouble comes, budgetwise, that Commerce has so much money that has to cover a lot of agencies?

We are going to get money for airports this year although the President does not like it, and I doubt that there will be many people on this committee that will vote against that bill when it comes up.

Mr. ALLEN. I doubt that the fact that the Maritime Administration is in the Department of Commerce has been controlling with regard to the budget, because if you will remember before Reorganization Plan No. 21, it was outside the Department of Commerce and my recollection is that we had more trouble then than we do now.

The CHAIRMAN. We want to see if we can stay on this subject of the ship.

We are going to have Mr. Allen back.

Mr. MILLER. Mr. Chairman, I have been asked to ask one question.

The CHAIRMAN. Yes.

Mr. MILLER. Do you think that private industry could operate this tanker without subsidy?

Mr. ALLEN. If we were to build it now; no.

Mr. MILLER. Would they have to put it under a foreign flag?

Mr. ALLEN. Not with our nuclear fuel.

The CHAIRMAN. I am going to excuse the witness now because we will have you back, Mr. Allen.

Mr. ALLEN. Thank you, sir.

The CHAIRMAN. Thank you very much. You had a right good dose this morning for the first occasion.

We are going to give you a chance to get your breath and come back later.

Now, Mr. McCone, please.

We are very glad that you could come down this morning, Mr. McCone. We regret that we kept you a long time but maybe you heard some discussion here to show you the interest of this committee in the subject that we have been delegated to perpetuate and promote.

STATEMENT OF HON. JOHN A. McCONE, CHAIRMAN, ATOMIC ENERGY COMMISSION

Mr. McCONE. Thank you, Mr. Chairman.

It is an honor and a pleasure for me to appear before this committee to discuss the U.S. program to develop nuclear power for the merchant marine.

I might say that this matter has a very special interest to me. As you know, Mr. Chairman, I was engaged in the shipbuilding business, built a great many ships, 475 to be exact, and I have also been in the shipping business and I have operated a great many ships, including some very large tankers and ore carriers, and now, having set that aside, I am in the business of trying to develop nuclear power for the propulsion of ships, and for other purposes.

The United States at the present time is carrying forward a broad nuclear development effort based upon the concept of Government and industry participation. While the bulk of this work has been aimed at the attainment of low-cost central station electric power, we have devoted a significant portion of our program to nuclear propulsion. Beginning with work for the Navy in 1948, which evolved into the submarine *Nautilus*, work has continued at an increasing tempo until we now can speak of our nuclear Navy. Similarly since the passage of legislation in 1956 to build the world's first nuclear merchant ship, we have devoted our energies to the development of marine nuclear propulsion systems where technical decisions are more directly influenced by commercial considerations.

It should be recognized that the Commission's reactor programs, both military and civilian, are generally complementary to each other. Other reactor programs have assisted in the development of the NS *Savannah's* pressurized water reactor and the *Savannah* in turn will contribute to the technology associated with later designs.

The Atomic Energy Commission and the Department of Commerce have worked jointly in the development and construction of the NS *Savannah*. To discharge our respective responsibilities under Public Law 848 the two agencies formed a joint technical group to which the responsibility for the development, construction and ultimate operation of the NS *Savannah* was given. In this way it has been possible to take full advantage of the capabilities of the Department of Commerce in the marine field and also utilize the laboratories and personnel of the Atomic Energy Commission in the nuclear aspects of the program. This has been accomplished without the need for shifting departmental responsibilities or duplication of functions.

Components of the *Savannah's* reactor system are now being received at the shipyard preparatory to final assembly. Cold testing of the reactor system will begin later this year and it is planned to achieve criticality early in 1960. We are encouraged with the progress of this vessel.

In conformance with the desires of the Congress and the President that the *Savannah* be the pioneer of a future nuclear merchant marine and also a floating laboratory for the futherance of the peaceful application of atomic energy, we plan a program of component improvement and upgrading of the *Savannah* nuclear plant during its early life. Information developed in this program will be given broad distribution here in the United States and to other friendly nations.

We are, however, mindful of major difficulties still to be resolved before the *Savannah* or its progeny can enter commercial service. Among the more vexing of these problems is the need for international agreement on safety standards and operating regulations.

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Also, solutions must be found to a number of legal questions dealing with liability in the operation of nuclear reactors in foreign countries. We are actively engaged in international discussions and studies aimed at resolving these problems.

The *Savannah* by conventional standards will be an expensive ship. This results from the fact that it is a prototype and suffers from the high cost associated with developmental projects. A second ship will also be expensive. Unfortunately, there is no easy way to resolve the difficult technological and operational problems on the drawing board or in the laboratory. Maritime nuclear propulsion, much like other research efforts, reaches a point when a concept or design must be tested in the final analysis by full-scale construction and operation.

In addition to the development and construction of a pressurized water plant for the *Savannah*, the Commission is engaged in a program directed toward the development of a nuclear reactor system capable of producing economic nuclear marine propulsive power. Design and engineering studies were initiated in 1956 by the Commission and the Department of Commerce to determine these reactor types with the greatest potential for maritime propulsion based upon safety, reliability of performance, and cost of operation. Two specific reactor projects resulted from these studies, namely, the engineering adaptation of a boiling water reactor for an early tanker application and a longer range full development program to design and build a land-based prototype of a gas-cooled reactor closed-cycle turbine propulsion system.

We have considered that maritime nuclear propulsion is closely related to the Commission's civilian power reactor program.

I would like to emphasize that point to you gentlemen, that there is a very definite relationship between the two and therefore the very extensive development program that we have in connection with central nuclear power stations will have a direct bearing on the progress in the maritime field.

Our 5-year civilian power reactor program is beginning to bear fruit. We have passed through a period of pessimism as to our ability to reach early competitive nuclear power. We are now confident that competitive power can be achieved in certain high fuel cost areas in the United States within the next decade. A nuclear ship can carry more cargo than a conventional ship and therefore has a credit which is not available to the central station power application of nuclear energy. That, in my opinion and in the opinion of the Commission, is a very important point because, as you know, in cargo ships and most particularly in tankers, you are always obliged to shut out cargo to make room for your fuel and that is not a necessity in the case of a nuclear powered ship.

Even so, we cannot predict when nuclear propulsion can achieve competitiveness since it will also depend upon a number of factors not all associated with the nuclear aspects of these projects. We can say, however, that we are not now at the point of economic competitiveness. Certainly, we need more experience in the development, the construction and the operation of such vessels before a firm appraisal can be made as to their commercial worth.

Other departments of the Government must determine when a vessel should be built, what type vessel should be built, and under what

commercial conditions nuclear power should be utilized by the Merchant Marine. The Commission on its part is willing and anxious to assist in carrying forward the development and construction of promising reactor systems for specialized applications and providing aid and information to appropriate Government departments responsible for the construction and operation of such ships.

Naturally the Commission will continue to exercise its normal responsibilities to insure the continued safe operation of these nuclear plants. However, we must resolve questions of responsibility with other regulatory groups such as the Coast Guard, the Public Health Service and various local groups. In addition there are international arrangements that must be completed prior to foreign operation.

There are few technical endeavors that require the attention to detail and precision of workmanship that are involved in both nuclear technology and shipbuilding. In both industries, safety is of primary importance and essentially overrides all other considerations. We have found much common ground for mutual understanding between these two industries. Just as a ship must be designed to operate for maximum safety to crew and passengers, so must a reactor be designed to operate with the utmost safety to its operators and the public.

The United States now has a broad technological base in the nuclear sciences and a strong equipment manufacturing capability. This potential permits us to conduct simultaneously a variety of nuclear projects, including maritime propulsion without adversely affecting presently planned military projects.

The attainment of competitive nuclear propulsion will require considerable effort and is not a goal which can be achieved easily. Our experience with development and construction in the nuclear industry has shown it to be very expensive. We, however, have been very encouraged by the fact that capital costs for nuclear plants are declining and avenues for further cost improvements are in sight. Further we anticipate uranium fuel costs will continue the present downward trend. Even so, it has been found necessary for the Government to assume the major financial burden and to provide the stimulus in pursuing an aggressive development effort including the construction and operation of prototype facilities.

Accordingly, if it is determined that we should actively support a program aimed at economic marine propulsive power, the Government must take the lead in this endeavor. Naturally, we should look to private industry to show the same farsightedness in the marine industry as they have in the electric utility industry. However, we should be realistic in recognizing that private operators must rely on the Government to bring development to a point where the technical feasibilities of promising systems have been demonstrated.

That concludes my prepared statement, sir.

The CHAIRMAN. Mr. McCone, going back to the budget message and this statement in the message with respect to legislation which states:

> Legislation should be enacted to assure that nuclear materials may be distributed for use as fuel on U.S. merchant ships.

Does that have reference to legislation that should come from this committee or some other committee?

Mr. MCCONE. I cannot answer that specifically, Mr. Chairman. I think that probably that is a matter that the Joint Committee on

Atomic Energy might deal with. It is a question of clarifying and laying down the ground rules of just what an operator can do in the way of moving his nuclear fuels out of this country and into foreign ports when they are aboard ship.

Just what committee should have jurisdiction, I really cannot say. I do not know.

The CHAIRMAN. I think, if we are going to take the budget message seriously, when the President says "should be enacted," it is a fair question for this committee to ask, is it a responsibility of this committee to pay attention to this directive?

Is it the responsibility of this committee or some other committee?

Mr. MCCONE. I cannot answer that question. I can attempt to get an answer for you, sir.

The CHAIRMAN. What is meant by this?

Mr. MCCONE. What is meant by it, sir, is that fuels for a nuclear powerplant are turned over to an operator or an owner of a ship in the event that they build a nuclear plant and then that ship, different from a central power station, travels over the oceans of the world and into foreign ports. Provisions must be made so that the owner of the ship who has the fuel in his possession—and this is nuclear material—can take it into a foreign port under authority of the law. It is a matter of clarifying legislation, sir.

The CHAIRMAN. Then, since this committee deals with the relationship between this country and other countries with respect to maritime laws and ports and operations, I gather that it is the responsibility of this committee?

Mr. MCCONE. I could not answer that. I will look into that for you, sir.

The CHAIRMAN. I do hope that you will look into it. That is what this series of meetings is called for. It is to ascertain just what program is being made in the application of nuclear energy to commercial merchant vessels and I do not know how to find out its present status unless we consult men like you who have the responsibility.

(The information referred to follows:)

PROPOSED LEGISLATION TO PERMIT THE DISTRIBUTION OF SPECIAL NUCLEAR MATERIAL FOR USE AS FUEL IN U.S. FLAG MERCHANT SHIPS OUTSIDE OF THE UNITED STATES

Sections 57, 103, and 104 of the Atomic Energy Act of 1954, as amended, contain provisions which cast some doubt on the Commission's authority to license nuclear-propelled vessels for operation beyond the territorial limits of the United States. Section 57b provides that "The Commission shall not distribute any special nuclear material (1) to any person for a use which is not under the jurisdiction of the Uniter States except pursuant to the provisions of section 54."

Section 54 prohibits the foreign distribution of special nuclear material except pursuant to the terms of our agreement for cooperation between the United States and foreign nations. Sections 57, 103, and 104 contain limitations applicable to the licensing of facilities which are substantially similar to the limitations of section 57b(1).

The proposed legislation would amend the Atomic Energy Act by adding a new section to be known as section 111 which would clarify the Commission's authority to issue licenses pursuant to sections 53, 103, and 104 for utilization facilities and to distribute special nuclear material for use as fuel at such facilities to be used for the propulsion of vessels outside the United States including areas under the jurisdiction of a foreign government.

Inasmuch as the proposed legislation involves an amendment to the Atomic Energy Act, it would appear to us to be properly within the purview of the Joint Committee on Atomic Energy.

Mr. CHAIRMAN. Is the fuel more expensive or is the construction of the reactors more expensive?

Mr. MCCONE. The construction of the reactor is more expensive.

The CHAIRMAN. Is that the big expense?

Mr. MCCONE. That is the big expense; yes, sir.

The CHAIRMAN. The expense of the fuel then is a minor part of propulsion by a nuclear system.

Mr. MCCONE. It is not a minor part. It is an important part but it is not the big part.

The CHAIRMAN. Well then, put it this way. The fuel that is necessary to operate a reactor, aside from the reactor cost, is that more expensive than conventional fuel?

Mr. MCCONE. You must realize that in a nuclear powerplant of the type we are now discussing, the energy in the uranium is actually consumed just as energy in coal is consumed. The only difference is that you buy it by the gram where you buy coal by the ton, but it is consumed nevertheless and in addition to the cost of the uranium itself, which is not very great, there is a very appreciable cost in the fabricating of the uranium into a usable fuel element and the reprocessing of it for further use after a fraction of the energy in the fuel element has been consumed.

These items all add up to quite an appreciable cost, not as much as high-priced oil but still very high. We are devoting very great effort to reduce these costs, to reduce the amount of uranium that is consumed, improve power density and efficiency, and also to reduce the fabricating and reprocessing cost. By accomplishing these steps, then we minimize the fuel charge and reduce it very materially below the cost of conventional fuel such as oil or coal and in that way offset some of the excessive capital charges due to the fact that your nuclear powerplant is quite expensive.

The CHAIRMAN. That is what I want. I wanted to leave aside the cost of constructing the reactor and those features of nuclear power and just ask the question, after they are eliminated, then what is the difference in the cost of conventional fuel and nuclear fuel?

Mr. MCCONE. As these developments bear fruit, the cost of nuclear fuel will be very, very much less, a fractional part of the cost of conventional fuel.

The CHAIRMAN. So that the day will come?

Mr. MCCONE. The day will come.

The CHAIRMAN. The day will come when you perfect the construction of reactors to the degree that nuclear energy then will be far more economical than the conventional energy?

Mr. MCCONE. From the standpoint of the fuel burnup itself.

Now, one of the very important aspects, of course, is the capital cost and this, I understand, you are setting aside for the purpose of this discussion.

The CHAIRMAN. We are now in the capital cost aspect of developing the reactors.

Mr. MCCONE. That is right.

The CHAIRMAN. You include that in the capital cost?

Mr. McCONE. That is right.

The CHAIRMAN. We are in that now. We have already invested in the capital costs.

Mr. McCONE. That is correct.

The CHAIRMAN. So then, if we do not experiment with this energy that you say will eventually be more economical than the conventional fuels, if we do not experiment with it in ship propulsion, when will we ever begin to us it in ship propulsion?

Mr. McCONE. Well, we have to experiment in power generation. Whether we have to experiment at the same time in ship propulsion and power generation is debatable, in my opinion, because both relate one to the other and ship propulsion will benefit from the development in central station work just as the central station work is now benefiting from the earlier work done by the Atomic Energy Commission for the Navy in naval propulsion.

The CHAIRMAN. The construction of the first nuclear ships by the Navy proved feasible and by their construction and the experience gained from it you have gone on to develop other ships in the national defense with nuclear propulsion.

Mr. McCONE. Yes.

The CHAIRMAN. Would it not be reasonable to say that they secured their knowledge by practical experience and accordingly it should be applicable to peacetime ships, commercial ships?

Mr. McCONE. Yes, I would think that that would follow. Yes, sir; although I would emphasize that the determinations as to the type and kind of ships to be built and when to build them is a matter for the Government agencies who have responsibility in that area.

The CHAIRMAN. I was going to get back to that. I noticed that in your statement, you said:

> Other departments of the Government must determine when, what vessel type, and under what commercial conditions nuclear power should be utilized by the merchant marine.

You made that statement.

Mr. McCONE. That is right.

The CHAIRMAN. That is in your general statement.

Mr. McCONE. That is correct, sir.

The CHAIRMAN. So then it is beyond your field to say that Maritime Administration should go into this but the demonstration you have already made in other ships would lead to the question why they do not go into it, would it not?

Mr. McCONE. Yes, I think that that is a good question, Mr. Chairman. I do feel, however, that they must recognize one factor in commercial ships, such as tankers and so forth, that is not existent in Navy considerations and that is economics.

The CHAIRMAN. Well, you know the Navy cannot operate or have not in the past been able to operate without the merchant marine in times of distress in this Nation.

Mr. McCONE. That is quite true, sir.

The CHAIRMAN. That has been the general history, has it not?

Mr. McCONE. And it still is; yes, sir.

The CHAIRMAN. Has that changed so much that you will not need the merchant marine in the future?

Mr. McCONE. Not at all.

The CHAIRMAN. Then, accordingly, you would say that the merchant marine should keep abreast of the Navy in development?

Mr. MCCONE. Well, I think that as long as we have a Navy and as long as we have the type of foreign commitments and responsibilities that we have we must have a merchant marine and a good one.

The CHAIRMAN. Now, as to this thing that I repeatedly see in the papers that we are encouraging other nations and helping other nations to develop nuclear energy for peaceful purposes and commercial purposes, are we doing more of that outside of the United States than we are doing in the United States?

Mr. MCCONE. Not by any means, sir. It is my opinion that the United States is carrying on the most aggressive and the broadest development program in nuclear energy of any country in the world.

I would like to say, sir, in saying that, that it does not necessarily mean that we are developing plants to produce more kilowatts, but we are developing more knowledge and more advancement in a very difficult science.

Some other countries have taken rather first generation type of relatively inefficient plants, and because of their power needs have built several large plants. This is understandable. This has not been our problem.

The CHAIRMAN. Is this aiding of foreign nations in the development of nuclear energy for various purposes in the foreign policy, or what policy is it in?

Mr. MCCONE. I think the use of the atom for peaceful purposes as an instrument of our foreign policy is a direct foreign-policy declaration of the President.

The CHAIRMAN. We seem to have had difficulty here with the legislation and the effort we have made to use this energy for ships. Just what does it mean when the statement was made that our administration was encouraging Canada to build an icebreaker powered by nuclear energy?

Mr. MCCONE. I cannot comment on that, sir, because I am not familiar with it personally.

The CHAIRMAN. Is your agency called in to collaborate with them with respect to furnishing them a reactor and fuel?

Mr. MCCONE. Not to my knowledge. However, this may have been a circumstance that has not been brought to my attention.

The CHAIRMAN. I do not want to belabor this veto of the atomic icebreaker. They were most interesting hearings on it. Without a doubt, it seems to have been proven that it was economically wise to have such a ship.

In your field, did you ever ascertain why Russia went into the construction of such a ship as this?

Mr. MCCONE. No. I think that an icebreaker is one place where nuclear power can be adapted to great advantage for the obvious reason that an icebreaker must be prepared to go on distant missions and to stay out for a long time. If is it not burdened down by fuel, and if its range of operation is not limited by the fuel it has on board, it is a great advantage.

Now, you mentioned the economics. I know nothing about the economic considerations.

The CHAIRMAN. Russia is not building this icebreaker because a part of their nation is in a cold latitude, is it?

Mr. MCCONE. I really do not know, sir.

The CHAIRMAN. Did you see the statement that they were sending it to the Antarctic?

Mr. MCCONE. Yes. I have seen a few statements. I have not seen any statements as to the status of their reactor to go into the icebreaker. I have seen statements that the hull has been built or laid down, and whether it has been launched or not I really do not know; but I know nothing about the reactor.

The CHAIRMAN. From your position and the position of your agency, do they have the ability and capability of putting this power in the icebreaker?

Mr. MCCONE. There is no question about that, sir.

The CHAIRMAN. They have it?

Mr. MCCONE. Yes, they have that, in my opinion.

The CHAIRMAN. Mr. Tollefson?

Mr. TOLLEFSON. Mr. McCone, what is the cost ratio, if you know, between the conventional powerplant in a ship and a nuclear powerplant? How many times more does a nuclear powerplant cost than a conventional powerplant?

Mr. MCCONE. I can answer that in this way: that the estimates that have been given to me indicate that this 60,000-ton tanker will cost about $30 million. I would imagine that an American-built conventional tanker of exact size and similar specifications would cost about $20 million in today's market in the United States. I would imagine if it were built foreign it would cost about $12 million.

Just comparing American costs, since the ships are comparable except for the nuclear plant itself, the propulsion equipment and the tanker space and the crews' quarters and so forth are alike, you might say that the nuclear plant in this particular tanker would cost $10 million more than the propulsion equipment in a standard tanker.

I think that is a reasonable estimate although I do not have specific figures.

Mr. TOLLEFSON. I did not anticipate that you would have it exactly but I wanted to get a general idea, if you had it.

The CHAIRMAN. Before you leave that, would you mind my asking a question? This gentleman is a pretty good source of information because of his background and his background justifies questions about this subject on which you are dwelling now.

Now, you spoke in your statement previously about the saving of space as between a nuclear-powered tanker and a conventional-powered tanker. Over a period of, we will say 5 years, the space and the additional cargo carried in this 60,000-ton tanker would approximate what in revenue? We are speaking of that against this $10 million.

Mr. MCCONE. Let me answer that in this way, sir.

The CHAIRMAN. Just give a rough estimate.

Mr. MCCONE. A tanker operating between New York and the Persian Gulf in continuous operation, a 60,000-ton tanker, would give up about 6 percent of its payload to make room for the fuel. I think that would be a reasonable statement.

The CHAIRMAN. What would be that 6 percent in revenue for a year?

Mr. MCCONE. Let me see.

The CHAIRMAN. Just roughly.

Mr. MCCONE. That tanker should make at least six round voyages so that it would carry, say, 350,000 tons of oil in a year and it would give up 6 percent of that, which would be 21,000 tons to make room for fuel.

Could I ask Mr. Morse what the maritime rate from Persian Gulf to north of Hatteras is?

Mr. MORSE. I am afraid I cannot answer it, sir.

Mr. MCCONE. I think it is $11 a ton although I would like to have that verified. So that, I would imagine it would be $200,000 or $250,000 in loss of revenue due to the cargo that you shut out in order to make space for your fuel.

The CHAIRMAN. In other words, this nuclear tanker would earn $250,000 more a year than an identical conventional tanker?

Mr. MCCONE. Well, that is not the whole story, Mr. Chairman.

The CHAIRMAN. Just going that far with it.

Mr. MCCONE. Let me carry this a little further.

In a conventional tanker, the tendency is to hold the speeds down because there is a very sharp increase in the fuel consumption as your speed goes up above, say, 15 knots, and you are familiar with that.

Now, this is not true in a nuclear tanker. You can apply more power and get more speed without the sacrifice of loss of cargo space. At high speeds you have to carry much more fuel so that in the final analysis you have to take into consideration a great many factors. This one figure which we have just developed does not demonstrate all of the considerations by any means.

The CHAIRMAN. Then would it be fair to say that at the present time in the light of the 20-year life expectancy of the ship the installation of nuclear power would pay for itself in the saving that you have been speaking of?

Mr. MCCONE. I would like to check that figure. I have not run a pro forma on it.

The CHAIRMAN. You have worked with ships and the cost of operation and you have been successful in it.

Mr. MCCONE. I would like to check the figure. I do not think it would be far off.

The CHAIRMAN. So that, ultimately there would be no loss and you would have the experience gained by this construction.

Mr. MCCONE. That may be true when you compare the nuclear plant to a conventional for an American-flag tanker. However, we have one other dimension here that we must take cognizance of. That is that the world tanker rates as well as the all-bulk rates are set by our foreign competition and that unfortunately is something that in the shipping business and tanker business you have to deal with.

The CHAIRMAN. If this ship had been in existence during the Suez crisis, there is no telling what it would have made.

Mr. MCCONE. Yes, that is right. Ships did very well for a short period of time.

The CHAIRMAN. You have a fat season and a lean season always in this industry.

Mr. McCone. Nevertheless, sir, I know of no large ships, tankers, or ore carriers for offshore trades that operate under the American flag. I know of none.

The Chairman. We do not have any offshore operations under American flag in tankers.

Mr. McCone. No, and the reason is, as this committee so well knows, that in a ship of 60,000 tons the difference in operating cost exclusive of any capital charges would run in the order of $350,000 to $400,000 per year, a thousand dollars a day as compared with the cost of a British, or Norwegian, or a German-flag ship. So this places an American operator with American-flag ships at a very serious disadvantage.

The nuclear-powered ship, the competition that it would face, would be not the American built, American operated conventional ship, but its foreign competitor and that is tough competition, I know. I have been in that business.

Mr. Pelly. Mr. Chairman, would you yield?

The Chairman. Mr. Tollefson has the floor.

Mr. Pelly. Could you yield?

I wanted to develop one thought that came as a result of the chairman's question.

Mr. Tollefson. I yield.

Mr. Pelly. That was the cost of the periodic replacements or overhauls that have to go into a reactor. Is that not very substantial, too, and would it not take the vessel out of service for a month or so?

Mr. McCone. Yes, that is substantial; and under present designs it is very serious. It must be done under the most exacting kind of operation because the fuel elements that you remove are highly radioactive and therefore must be taken out with great care.

However, one of the programs that the Atomic Energy Commission is devoting a great deal of attention to and on which it is spending a great deal of money is in simplifying just that operation because it is a serious problem in our central powerplant program also.

It is also a serious problem in the plutonium production reactors at Savannah River and Hanford. This is something we are working on continuously.

Right now it is a very costly operation.

Mr. Pelly. As the record reads now it looks like in 20 years the nuclear-propelled vessel would practically pay for itself because of the saving in space.

It seems to me that if you put in the record this other phase it would be different.

Mr. McCone. I would not like to leave that impression with the committee without having the benefit of a study because this is in the field of ship operating costs and, frankly, it is not something that I have been dealing with.

If the chairman would like that from me, I would be very happy to develop it.

The Chairman. Yes. I do not know any more able source from which we could get that information than you because you have a combination of ability and experience and knowledge about this matter where some of the other witnesses come before us and just simply only know one field. So that, I wish you would develop that more for the record.

Mr. McCone. With your permission, I will do that.
(The information referred to follows:)

EXTENT TO WHICH THE INCREASED CARGO CAPACITY OF A NUCLEAR TANKER WILL DEFRAY ITS HIGHER CAPITAL COST

The extent to which the increased payload of a nuclear powered tanker could aid in the defrayment of its higher capital cost can only be estimated at the present time. This results from a variety of contributing factors which cannot be fully analyzed owing to the early state of design and certain operating limitations. For example, assume a 60,000 deadweight-ton tanker powered by a 30,000 shaft horsepower boiling water reactor nuclear propulsion plant with a design sea speed of 18 knots built in the United States and operated under the U.S. flag. On a round trip between the Persian Gulf and the New York area the fuel oil consumed by a conventional vessel of this power and speed would reduce its payload by approximately 6,000 tons. A nuclear vessel would of course require no fuel oil and it might seem than its payload would be increased 6,000 tons. However, the heavier nuclear plant must pay a weight penalty of about 2,000 tons over a conventional plant. The actual increase in payload for the reference nuclear tanker is then about 4,000 tons. Such vessel would make 6.5 round trips per year thus carrying 26,000 additional tons of cargo. Using the flat rate of $13.05 per ton (actual rates fluctuate above and below this figure) for bulk oil carried between the Persian Gulf and New York the vessel's earnings would increase $339,300 per year. The cost of such a nuclear tanker would be about $10 million greater than a conventional vessel of comparable size. Thus over a 20-year life the increased cargo capacity of the nuclear tanker could earn an additional $6,786,000 or 67.8 percent of the additional cost of a nuclear vessel.

The Chairman. Mr. Tollefson.

Mr. Tollefson. Do you know what other nations are doing with the development of nuclear power for merchant ships outside of this icebreaker that Russia has built?

Mr. McCone. Yes. I have had a report on that recently. It seems to me that it could be summarized by saying that other nations are studying the problem, some of them are forming industry combinations with the idea that they might initiate a program, but I know of no construction program that is actually underway. There are important interests in Japan and likewise in Germany that have given this very serious consideration.

As recently as last week I received a letter from the head of the largest shipbuilding company in Germany telling me of what they were doing in the way of preparing to build this type of ship and asking if I knew of any commercial interests who might like to sit down and talk with them about placing an order for a ship.

Mr. Tollefson. Could you supply for the record more detailed information than you have just given us with regard to that?

Mr. McCone. I would be very happy to do that, sir.

Mr. Tollefson. Do you mind if he supplies additional information?

The Chairman. Yes, that will be all right.

(The information referred to follows:)

PLANS OF FOREIGN NATIONS WITH RESPECT TO NUCLEAR-POWERED MERCHANT VESSELS

UNITED KINGDOM

An admiralty committee has been established to study the use of nuclear reactors for the propulsion of merchant ships. Preliminary designs for a gas-cooled, heavy water moderated reactor suitable for shipboard installation have been made. Designs for a boiling water reactor and a liquid-organic moderated reactor system are underway. In August 1958 a news announcement was made to

the effect that plans are being made in the United Kingdom for the world's first submarine tanker. According to the announcement, the Saunders-Roe Co. has been asked to prepare a preliminary design of an 80,000-ton submarine to travel at 35 knots. It would be used to carry iron ore or oil. The work is said to be financed by the Mitchell Engineering Co.

The United Kingdom is at work on a nuclear-powered submarine and a land-based prototype of the nuclear plant is under construction at Dounreay, Scotland.

FRANCE

Several French industrial organizations interested in industrial application of atomic energy are doing design work on nuclear-powered merchant ships. Two French groups, Indatom and France Atome, are working on competitive design for a 40,000-ton, 20,000 shaft horsepower tanker. Three designs have been prepared: gas-cooled reactor (Indaton); pressurized water reactor (France-Atome-Chantiers de l'Atlantique); and boiling water reactor (France-Atome, Societe des Forges et Ateliers du Creusot). A choice of the reactor system to be adopted will be announced by the French Commissariat a' l' Energie Atomique (CEA) and the merchant marine in 1959. In addition to the above, reports indicate that the new 55,000-ton liner, *France*, will be built as to allow for possible future conversion to nuclear power.

The French Government is giving high priority to the development of a nuclear-powered submarine. Design is underway though no decision has been made as to the type of reactor to be utilized, although it is expected to be the pressurized water type.

WEST GERMANY

Several German concerns are interested in nuclear power for merchant ships. One such organization known as FRR, is studying the pressurized water and gas-cooled reactor concepts with a view toward designing and building a 40 MW (thermal) reactor to be installed in a 22,000-ton 10,000-horsepower Olympic class tanker. Plans call for a land prototype to be constructed in 1959 with the ship to come into operation by 1961. A second concern, known as Interatom, a joint subsidiary of Demag A. G. of Germany and Atomics International, a U.S. concern, has entered into an agreement to develop an organic moderated and cooled reactor propulsion plant. If development and design proceeds satisfactorily it is reported that construction of a ship would be started. In addition to these, plans for a 45,000-ton nuclear-powered tanker have been announced by Deutsche Werft Shipyards.

ITALY

An organization composed of Fiat and other Italian industrial concerns has prepared designs for a propulsion reactor for a 68,000-ton, 32,000 shaft horsepower tanker of the *Agrigentum* type. The reactor is a pressurized water type of 74 MW (thermal).

The new 31,500-ton, 60,000-horsepower *Leonardo da Vinci* is reportedly being constructed with a view toward future conversion to nuclear propulsion.

NETHERLANDS

In the Netherlands, activities in nuclear marine propulsion are being carried out by three groups.

1. The Foundation for Propulsion for Merchant Ships (SKK) which by recent reports plans to purchase a reactor for installation in a tanker.
2. The Institute for Ship Propulsion of Rotterdam is designing a 30,000-ton nuclear tanker. The design calls for a pressurized water reactor.
3. The Netherlands Navy Ministry has set up a working group to study construction of a nuclear submarine.

NORWAY

The Rederiatom organization, an association of major shipowners, is working on preliminary specifications for a nuclear-powered merchant ship using a boiling water reactor. The Jener Center at Kjeller, Norway, is utilizing a pool-type research reactor to carry out research and training activities related to nuclear propulsion for ships.

Several large Norwegian shipowners are making independent studies on the feasibility and economics of nuclear-powered ships.

SWEDEN

The Swedish Shipbuilding Research Foundation has made a survey of the application of nuclear propulsion to merchant ships. It is now studying different reactor types, shielding problems, etc.

Ships, Inc., an affiliate of Cities Service, is collaborating with Gotawerken Shipyards on the design of a 65,000-ton, 22,000 shaft horsepower tanker. The vessel would be powered by a 100 MW boiling or pressurized water reactor. If the project moves into the construction phase, launching is scheduled in 1965.

CANADA

Canadian interest in nuclear propulsion for ships centers around the development of nuclear-powered submarines. Some preliminary discussions have been held between the United States and Canada concerning an icebreaker, although plans for such a vessel are very tentative.

JAPAN

Strong governmental support and active participation by industry indicates that the Japanese atomic energy program places considerable emphasis on nuclear propulsion for merchant ships. Six nuclear-powered merchant vessels are at some stage of design. These include a 65,000-ton tanker, an ore carrier, two emigrant ships, a submarine tanker, and a coastal guard ship. All these designs call for the pressurized water reactor. Nineteen hundred and sixty-eight has been indicated as the target date for the completion of the first ship, though an earlier date of 1965 has been used.

A plan to build one 80,000-ton and three 40,000-ton tankers was published in the summer of 1958 by the Atomic Ship Research Council (Japan Atomic Industrial Forum). This brings the total number of proposed Japanese nuclear merchant ships to 11.

According to plans announced recently the first nuclear vessel built in Japan will be an oceanographic survey vessel in addition to being an experimental ship. She will utilize a pressurized water reactor powering a pair of 4,000 horsepower steam turbines and have a speed of 19 knots.

U.S.S.R.

The Russian program centers around the icebreaker, *Lenin*, which is scheduled to begin operations in the spring of 1959. The *Lenin* employs three 90 NW (thermal) pressurized water reactors to power four turbogenerators having a total power of 44,000 shaft horepower. It has a speed of 18 knots in clear water. The ship can operate on any two reactors, the third serving as a reserve unit.

EAST GERMANY

There is information which indicates that work is underway in East Germany to explore the practical possibilities of nuclear ship propulsion. Work centers around a 15,000-ton dry-cargo vessel which is to be equipped with a conventional steam plant which can subsequently be modified to utilize a nuclear reactor as a heat source. The East German group is reported to be cooperating closely with the U.S.S.R.

POLAND

The Polish Institute for Nuclear Research in conjunction with the Maritime Institute and the Central Bureau of Ship Construction is actively studying the application of nuclear energy to ship propulsion. Work is being done on an organic-moderator reactor for a 35,000-ton, 24,000 shaft horsepower merchant vessel.

YUGOSLAVIA

The Yugoslavian Federal Commission for Nuclear Energy is preparing designs for a 40,000–50,000-ton nuclear tanker.

Mr. TOLLEFSON. What, if anything, is private industry doing in the direction of developing nuclear powerplants for merchant vessels?

Mr. MCCONE. I think that several of the major oil companies have given this question quite serious consideration.

I know of no construction program that is under way. I know of no company that has appropriated money other than for study purposes. It is a rather bad climate. The shipping business is rather bad right now and most of these companies have ships laid up and the rates are very low and you find them not thinking very constructively about new programs.

Mr. TOLLEFSON. In view of that fact, and this is what I was getting at, is it likely that private industry will do very much until the feasibility of such powerplants in merchant vessels has been proven by what the Government is doing?

Mr. MCCONE. No, I do not think that private industry will do too much in this. They might join in some partnership arrangement with the Government in order to get experience and to get an advance position, but on the basis of the pure economics, and that is what they have to look at, I do not expect that they would do too much.

Mr. TOLLEFSON. So that, it is essential that the Government move first in this field?

Mr. MCCONE. If this is to go forward, as I said in my statement, the Government has to do something about it.

Mr. TOLLEFSON. I have just one other question.

Mr McCone, you have stressed the safety factor in your statement. Is there any reason to believe that the problems of safety will not be overcome within a relatively short period of time?

Mr. MCCONE. I think you will always have a hazard in a nuclear-powered ship for the simple reason that, as the ship operates, the plant becomes radioactive and, if an incident occurs, if there is a radioactive discharge through a fire or some sort of accident, you might have very serious consequences.

I think the best we can hope for is improvements in design which will give the maximum amount of safety but will not give complete safety and then the development of operating procedures, care with vessels entering ports and so forth, so that we can be sure that we are not going to have accidents. I do not think that you can look forward to the elimination of the hazard entirely.

Mr. TOLLEFSON. I did not mean it perhaps in the way it sounded. The safety factor is not of such concern that we should not go ahead with the development of nuclear-powered merchant vessels, is it?

Mr. MCCONE. I think that is right.

Mr. TOLLEFSON. That is all, Mr. Chairman.

The CHAIRMAN. Mr. Garmatz.

Mr. GARMATZ. Mr. McCone, at page 3, in your first paragraph, you say:

> We are, however, mindful of major difficulties still to be resolved before the *Savannah* or its progeny can enter commercial service.

Then you say:

> Among the more vexing of these problems is the need for international agreement on safety standards and operating regulations. Also, solutions must be found to a number of legal questions dealing with liability in the operation of nuclear reactors in foreign countries.

I wonder if you can elaborate on that and also on the last sentence:

> We are actively engaged in international discussions and studies aimed at resolving these problems.

Will they be finished when the *Savannah* is ready so that we can travel around the world with her?

Mr. McCone. I think so. What we have done there is to start informed international discussions to try and arrive at operating procedures with the principal maritime countries where this ship will visit so that when the ship goes into operation the procedures under which the ship can enter foreign ports will be established and difficulties will not be encountered.

Mr. Garmatz. What would some of the difficulties be?

Mr. McCone. I would point out that we would like to avoid the situation that occurred with the *Skate* when it turned up in Copenhagen, I believe, and was not permitted actually to enter the harbor.

This is underway. Our people are in conferences with the maritime authorities of a number of nations.

In addition, the International Atomic Energy Agency in Vienna, whose Director General is Sterling Cole, has the problem in hand. The third-party question liability which is referred to here is a very serious one because, if there should be an accident, there is some question as to just how the operator of the vessel and the manufacturer of the reactor is going to be protected against suit by the damaged citizens of a third country. This not only has to do with the ship but also with a central station plant that an American manufacturer might build in Switzerland or in Belgium or someplace else.

This is being approached by a number of groups. I mentioned two. The OEEC countries are likewise dealing with some form of a convention to solve this problem of third party liability but it must not be ignored because it is there and it is extremely serious.

Mr. Garmatz. That is all.

The Chairman. Mr. Mailliard.

Mr. Mailliard. I have no questions.

The Chairman. Mrs. Sullivan.

Mrs. Sullivan. I have no questions, Mr. Chairman.

The Chairman. Mr. Miller.

Mr. Miller. Mr. McCone, how many nuclear powerplants are now in the process of construction throughout the United States, and how many are planned for, say, the immediate future, to be started within the next couple of years?

Mr. McCone. There are about 14 plants that are either under construction or in the design stages. These are central station plants of various sizes, several of them quite large and a number of them are small. I think that all save maybe two of those will go forward. Many of them are advanced now and nearing completion.

In addition, there are a number, and I do not know just how many, of reactor experiments which themselves are quite sizable, running up to as much as 5,000 kilowatts or about 5,000 horsepower.

In the marine field, there are a total of 33 nuclear submarines of which I believe five or six have been completed, an equal number on the ways, and the others programed.

There is a nuclear-powered destroyer, a nuclear-powered cruiser, and a nuclear-powered aircraft carrier. The nuclear-powered aircraft carrier will have eight reactors in it. The larger submarines, I believe, have two. In the case of the aircraft carrier, there is a land-based prototype built and operating in Idaho with two reactors.

There are several land-based prototypes of the submarines at various places.

Mr. MILLER. Then we have made a great deal of progress in the last 10 years in applying nuclear power to uses other than to war?

Mr. MCCONE. Oh, there is no question about that, sir.

Mr. MILLER. As we go along there is more and more progress being made.

Mr. MCCONE. That is right. We intend to initiate some more advanced programs.

Mr. MILLER. In other words, the General Electric Co. has one of those prototypes that they built out in Vallecito, Calif., that proved much more efficient than they thought it was going to prove; is that true?

Mr. MCCONE. That is right. It will interest the committee to know some of the advances that have been made.

Several years ago, we built a boiling water reactor, the type referred to here, and we estimated that it would have 20,000 thermal kilowatts of heat. We gradually increased its power density and power level until we got to 60,000 out of the same plant.

Now we are rebuilding it this year and we are going to get 100,000.

Mr. MILLER. Where is that?

Mr. MCCONE. This is at Argonne National Laboratory. Here is a plant that will produce five times as much heat output out of the same pressure vessel and so forth with a new core and some different pumps and so forth. That is a pretty good measure of some of the progress that has been made in this field.

Mr. MILLER. Is that not substantially the same experience that General Electric had with their Vallecito plant?

Mr. MCCONE. That is right. From the information at Vallecito, they designed Dresden which is a big plant and are now designing another at Humboldt Bay for the Pacific Gas & Electric Co.

Mr. MILLER. The point I make is that in this field we did not hesitate until we had a perfect reactor and perfect tool before we began to apply it; did we?

Mr. MCCONE. You have not really in the marine field either, sir, because you have more nuclear reactors either in operation or built for marine propulsion if you consider the Navy a part of it than you have for central station plants.

Mr. MILLER. Then you do not think that it is premature to consider the application of nuclear energy to commercial ships at this time?

Mr. MCCONE. I do not think any real advance is going to be made by considering the building of a tanker at this particular moment, sir. I think that the development program that we have and that we are carrying out will advance the art. Just as rapidly as though you built it into a tanker. What you do not show by the type of work we are doing is to demonstrate. That is what you do not show.

Mr. MILLER. In other words, we get back to that old prestige. If Germany or Japan puts a tanker or a merchant ship in the field before we do, what effect has that prestige on the rest of the world?

Russia put up a sputnik before we did and we are suffering from it yet. Did we save any money in not beating Russia to it?

Mr. MCCONE. No; I do not think that we did, sir.

Mr. MILLER. In other words, we lost. Our national prestige fell.

In the whole shipping industry, do we not place much emphasis on prestige, particularly with these nations that we have to court to our side? Has not England prestige ships afloat?

Mr. McCone. I am a great believer that the American flag flying on the great ship United States is a matter of great pride to this country.

Mr. Miller. We have to keep that prestige. It is a rather cheap investment, is it not?

I happen to sit on another committee that is very much interested in other phases of this thing where we are paying the costs now for our failure to develop some of these missiles and we are going into crash programs because we saved some money some years ago by not building them, and I do not like to see that applied to the American merchant marine.

I am not going to ask you to draw a conclusion.

Mr. McCone. With respect to this prestige matter, I feel that no country other than the United States or Russia can build a nuclear-powered ship at the present time because these reactors must be powered with enriched fuel. This is fuel which is enriched with the element of U^{235}, and that comes from Oak Ridge and nobody else has it except Russia and ourselves. England has a little and is now trying to get some more from us. To my knowledge, they are making no effort to build a reactor for shipboard purposes.

So that, unless Germany or Japan can work out an arrangement with us for this fuel, they cannot build one of these reactors because a natural uranium reactor is of such proportions that it destroys the economic advantages.

Mr. Miller. As long as we have introduced the subject of Germany and Japan, I was in Japan this fall and saw some of their shipyards. Every time I go home I see the *World Enterprise* in San Francisco Bay, the biggest tanker afloat. It is quite a prestige ship, built in Japan.

When we are trying to keep Japan and Germany in the orbit of the free world and they are in a position where they want to build this ship, do you think we are going to deny them the enriched uranium?

Mr. McCone. I would not think so; no.

Mr. Miller. I would not think so either.

Mr. McCone. I would not think so.

Mr. Miller. Would it not be worth a few extra dollars to us to be the first in this field rather than have to pass enriched uranium over to Japan and Germany to let them come in with their flag flying on this ship?

Mr. McCone. Yes; I can see the appeal for this ship just as all of these things that are first have their appeal.

Mr. Miller. They have. We cannot deny we lost more prestige over sputnik than anything that has ever happened to us.

Mr. McCone. Either we lost prestige or the other fellow gained it.

Mr. Miller. Now, I was in England when it happened and the tendency of the British press was to say, "Here is where the big guy got his comeuppance." They were chortling over the thing that somebody else beat us to it.

On calmer reaction the British press dropped that line. You saw it. It was there.

Mr. McCone. I was in Germany at the time. I saw it.

Mr. Miller. Less than 10 days afterward Germany was selling sputniks for the children. I brought one home for my grandson. Maybe you brought one home, too. We lost. Incidentally, I am very proud of the fact that Vallecito happens to be in my district, near your great Livermore plant. I am very proud of that.

That is all.

The Chairman. Mr. Pelly.

Mr. Pelly. I have no questions.

The Chairman. Mr. Zelenko.

Mr. Zelenko. Mr. Commissioner, I am interested in the statement on page 5 in which you say:

> We can say, however, that we are not now at the point of economic competitiveness. Certainly, we need more experience in the development, construction, and operation of such vessels before a firm appraisal can be made as to their commercial worth.

I believe that agrees with Secretary Allen's statement on that particular point that before you really can get down to the competitive value or the commercial worth, you should have a ship in operation. That will really tell you what is what, whether your research is valid or not.

Following that, I would like to ask you this question. Do you not think that money for the development of such a vessel would be money well spent for all of the reasons indicated here, prestige, economics, defense, and every other reason? Do you have an opinion on that?

Mr. McCone. The operation of the nuclear part of the ship, which is the area of my particular responsibility, can be demonstrated, as it was in the case of the *Nautilus* and it now is in the case of the aircraft carrier in prototypes which are land based, and very satisfactorily. There is, however, the necessity of operating a ship of this kind as part of a transportation activity and also of demonstrating the problems that Mr. Pelly brought up, the question of the taking the ship out of service and removing the core of the reactor and all that sort of thing. That must come ultimately from a ship operation. That is correct.

Mr. Zelenko. Well, it would also be part of a defense activity. As you yourself indicated the merchant marine is part of our defense.

Mr. McCone. I think the merchant marine is an essential part of our defense and our mobilization planning. There is no question about that.

Mr. Zelenko. I believe you would agree with me that if we have a fleet of naval vessels running on nuclear power it would be very difficult to go through any type of operation as to speed and maneuverability and stay at sea with tankers running on conventional speed and conventional fuels and conventional capacities for the emergency that perhaps we hope does not take place but which may take place.

I am trying to bring out, in asking a question along this line, that as long as you said you agree that a merchant fleet is part of the defense activity of this country, do you not think money at this time would be well spent for a number of reasons in the construction of such a vessel

because you indicate that you cannot tell if it works unless you have something to work it on.

The big question is, will the money be well spent?

Mr. McCone. That is correct.

Mr. Zelenko. I think you must take in all these other factors, prestige, defense, economics, when you weigh whether you should spend a dollar or not. That is why I ask you, taking all these factors into consideration, whether the authorization and building of such vessel, in your opinion as the Atomic Energy Commissioner, would be money well spent.

Mr. McCone. It would be my advice and belief, and this is getting a little out of my sphere, that the development of the nuclear plant which will take place in the efforts that are now going on and are carefully programed will so advance the art that a ship built a little later will demonstrate a usefulness that a ship built now will not demonstrate.

Mr. Zelenko. Then do you mean to qualify your statement that "we need more experience in the development, construction, and operation of such vessels before a firm appraisal can be made," because I seem to get from your statement that in order to find out whether this will work we should build such vessels.

Are you qualifying by saying we should hold up the building of the vessels?

Mr. McCone. There is no question in our mind and no question in anybody's mind that a nuclear plant can be placed in a ship and furnish the power or energy to drive the ship. There is no question about that.

The question is, to do it competitively and efficiently and this requires several things: It requires development. It requires construction, and ultimately it requires operation.

Now, there is a great deal of development that is going on, sir, and what I am trying to say is that this development will go on and will produce a technology which will make an infinitely better ship in a relatively short time.

Mr. Zelenko. You see, that is the point I do not understand in your statement.

You say: "We need more experience in the development, construction and operation of such vessels." I want to know when you talk of development, are you talking of general atomic development or development, construction, and operation of atomic vessels in order to see if it works out or not?

I do not mean to engage in semantics but I want to know if your oral statement is a qualification of the statement you made at the top of page 5.

Mr. McCone. Before we should build a ship, I would like to see further development done on the boiling water reactor and the gas-cooled reactor, closed-cycle turbine both of which offier prospects for efficient competitive operation that cannot be attained by the type of reactor now being placed in the *Savannah*. The operation of the *Savannah*, however, will demonstrate a great deal of the operability and the acceptance of a nuclear-powered ship in the maritime field.

Mr. Zelenko. Is it your opinion, then, sir, that we should wait with the going ahead of any construction or authorization of atomic-powered vessels until we see how the *Savannah* works out?

Mr. McCone. Yes; that would be my advice. I would urge that this be carried on a little more deliberately, I think it would be a more prudent approach to the problem and I think that there is not the urgency that requires us to go forward now and to do something that is bound to represent considerably less than an efficient, satisfactory plant.

Mr. Zelenko. Could you analogize your statement to the validity of the Navy proceeding with the building of nuclear ships? Should they not wait also until further development, if what you say is logically correct?

Mr. McCone. I think that the Navy has had an entirely different consideration. The ability for the submarines to submerge and to stay submerged for 56 days is extremely important where the ability for an aircraft carrier to be out more months is likewise very important.

This is not so important with commercial vessels; nor is it so important with a tanker that is serving the fleet such as a fleet oiler.

Mr. Zelenko. On the question of importance, I believe that Mr. Miller and you agreed that one of the factors of importance in the world today is the matter of prestige.

Mr. McCone. That is correct.

Mr. Zelenko. From a prestige standpoint, I think you would agree that it is important to be first.

Mr. McCone. There is no question about that.

Mr. Zelenko. All right. Now that is the prestige angle.

Mr. Miller. Would the gentleman yield?

Mr. Zelenko. Yes; I yield.

Mr. Miller. Mr. McCone, in your own statement you speak of beginning work on the *Nautilus* in 1948, and this is 1959. Are we not dragging our feet some place in 10 years after all of this experience if we are not in position to yet go into this field?

Mr. McCone. I do not think it is a question of dragging our feet, Mr. Miller.

Mr. Miller. To be frank, if you had your way, would you not like to see this ship built right now?

Mr. McCone. Sure from a prestige standpoint.

Mr. Miller. I think our minds meet.

There is another curtain that is pulled between them.

Mr. Zelenko. One more question, Mr. McCone. Is part of your opinion to delay the building of this based on the administration's budgetary problems?

Mr. McCone. The administration gave us all the money we need in this field, sir.

Mr. Zelenko. I mean in the building of this ship, because the Secretary got up and said, "Well, if we had the money it might be well to go ahead."

Do you base your opinion partly on that consideration also?

Mr. McCone. No; I cannot comment on that because we were given all the money we asked for for marine nuclear propulsion both for the Navy and for the merchant marine for fiscal 1960.

Mr. Zelenko. If it is not divulging anything which is of a secret nature, can you tell us just what moneys and for what your Commission was given in the marine field?

Mr. McCone. This is in the commercial field exclusive of the Navy. From 1958 we spent $1½ million. In 1959 we will spend $4.4 million. In 1960 we will spend $6.6 million. This is exclusive of the support of the *Savannah*, which is handled in the Maritime budget; $6.6 million is the amount that we asked.

Now, our Marine Division requested $9 million. When we analyzed their detailed request and related their undertakings to the undertakings of our Research Division as well as our Nuclear Power Division and the Navy and so forth, we saw that there was an overlap so that we could screen off about $2½ million.

Mr. Zelenko. Without going into detail, just what is that $6 million being spent for in your Commission?

Mr. McCone. In addition to the $6.6 million, of course there is a very great deal of money being spent in research in fuel elements and reactor design, and so forth.

Mr. Zelenko. Is that marine?

Mr. McCone. It is for the whole nuclear art and the whole thing ties together, you see. As far as the $6.6 million, I do not have the specifics. I can get it for you, sir.

Mr. Zelenko. What I meant, Mr. Commissioner, was not what the money is being used for for your entire appropriation but specifically on marine.

Mr. McCone. The majority of it is going into the development of the marine boiling water reactor and the gas-cooled closed-cycle gas turbine.

The Chairman. Mr. Gross.

Mr. Gross. Mr. McCone, you attach great importance to the matter of prestige. You have reiterated that two or three times. You also, as a citizen and a taxpayer and Government official, attach significance, I am sure, to the prestige of the United States as a solvent Nation, do you not?

Mr. McCone. Indeed I do, sir.

Mr. Gross. Well, we seem to be doing pretty well in the matter of prestige. We are building atomic submarines, are we not? How many atomic-powered submarines do we have?

Mr. McCone. I think we have five or six. We have a total of 33 which have been authorized and are either under construction or in the program.

Mr. Gross. I believe you spoke of an atomic-powered destroyer, cruiser, and aircraft carrier.

Mr. McCone. That is correct. Those are all very important, sir.

Mr. Gross. I seem to get the impression that you joined with my colleague, Mr. Miller, in saying that we lost considerable ground as a result of the launching by the Russians of sputnik and I am sure that a good many, perhaps you yourself have heard that if Jupiter-C had been given the green light we could have put a vehicle in orbit before the Russians put up their vehicle, so that it was not necessarily a lack of consideration on the part of Congress that we did not have the first vehicle in orbit. If what we hear is true is was rather a lack of unity on the part of the Armed Forces, some foul up in the Armed Forces that failed to permit the green light being given to Jupiter-C. Do you agree with that; have you heard reports that we might have put a vehicle in orbit before the Russians?

Mr. McCone. Yes, I have heard reports. I have not examined it very carefully, Mr. Gross. I think that the decision that was made was that every effort should be placed on developing Jupiter as an intermediate ballistic missile and that anything that would divert from that primary goal would be a mistake.

I really think that is probably what was in the mind of the Defense Department when that decision was made.

I was not here at that time and naturally I have only gotten it from outside, but I could see how they might reach that kind of conclusion.

Mr. Gross. At the rate some of the foreign countries have been withdrawing their gold from the United States, I wonder if they are giving consideration to the prestige and solvency of this country?

Mr. McCone. Well, I, as a citizen, cannot help but be alarmed as you are over the flight of gold from this country, over the loss of our export business, over the incident that you mentioned, I believe, of the failure to subscribe to the most recent issue of bonds. All of those things cause me great concern and that is one of the reasons why I am in complete support of the President's objective of trying to help to rectify this by keeping our Government expenditures at a very minimum and getting our budget in balance and our house in order. I think that is very important.

Mr. Gross. I am glad to hear you say that, prestige notwithstanding.

I am very pleased to hear you say that.

Some of these things can be delayed to a later date when we do have our house in order if ever we do have our financial house in order in this country.

Did I understand you to say that to be competitive an atomic tanker would almost have to be registered under a foreign flag?

Mr. McCone. I pointed out that the competition in the tanker business is set by the foreign operator and the foreign-flag ship. Make no mistake about that. That is where the competition comes from. That is why all of the offshore tankers of size operate under foreign flag.

Mr. Gross. So that, despite the savings on fuel space, and we have had that pretty well developed here, this 60,000-ton nuclear-powered tanker would almost of necessity have to be registered under foreign flag in order to operate?

Mr. McCone. Yes, I told the chairman I would submit a study on that.

Mr. Gross. If that be true, then the prestige again would not be enhanced very much if it were flying a foreign flag.

Mr. McCone. No, I do not see any way, certainly, under existing law that it could operate foreign flag because of the control of the fuel itself.

Mr. Gross. But if it were to operate competitively and if it were ever to pay out, it would have to operate under a foreign flag, would it not, unless the Government continued to pour money into it?

Mr. McCone. It is to make up this difference of a thousand dollars a day of which I spoke. That is there every day.

Mr. Gross. It would be an enormous subsidy, would it not?

Mr. McCone. Yes, it would be an enormous subsidy.

Mr. GROSS. So that where you might save on the space for fuel for a powerplant you would lose again on the other side, would you not?

Mr. MCCONE. Yes.

Mr. GROSS. On a competitive basis?

Mr. MCCONE. There would be that matter that would have to be taken care of. It is taken care of in our American flag berth services by operating differential subsidy, as you know.

Mr. GROSS. In that case you would have a tremendous capital investment, would you not?

Mr. MCCONE. You would have two costs. You would have to overcome the capital investment differential, which I mentioned is $10 million, and the increased carrying capacity, as the chairman pointed out, would help to do that. Then you would have this operating differential which would have to be dealt with. There is no question about that.

Mr. GROSS. Which would be a heavy differential.

Mr. MCCONE. $1,000 a day.

Mr. GROSS. Is the Atomic Energy Commission or this Government making enriched uranium available to foreign countries?

Mr. MCCONE. Yes; with limited enrichment.

Mr. GROSS. What would you say is the cost of a gram of enriched uranium?

Mr. MCCONE. The price of U^{235}, the published price is $16,000 a kilogram.

Mr. GROSS. $16 a gram?

Mr. MCCONE. $16,000 a kilogram.

Mr. GROSS. I asked you because a year ago when the hearings were held on the icebreaker, Mr. Davis was before the committee and, at that time, he said that you would make available or were planning to make available 30 tons of enriched uranium to foreign countries.

Mr. MCCONE. That is correct.

Mr. GROSS. Are you in a position to say how much you have made available?

Mr. MCCONE. We have made available all of it but none of it has been withdrawn as yet.

In that particular transaction, sir, what he was I think referring to was a commitment made to the International Agency in Vienna, to make available to them 5,000 kilograms of enriched uranium. This was to stimulate the activity of the Agency. That offer still stands. We have entered our drafting of the final pages of an agreement under which this will be handled and the price that they will pay will be the domestic price which at the present time is about $16,000 a kilogram.

Mr. GROSS. Or $16 million per metric ton?

Mr. MCCONE. That is correct.

Mr. GROSS. How are they paying for this uranium?

Mr. MCCONE. Well, in the case of the International Agency, since there has been no withdrawal of the fuel, this has not been dealt with.

Mr. GROSS. We are not going to give it to them, are we?

Mr. MCCONE. No. The provisions of the agreement are that it will be paid for.

Mr. GROSS. I just wondered what kind of money they would use to pay for it, if any.

Mr. MCCONE. Well, you are not familiar with other understandings, such as the Euratom agreement which was outside of this commitment to the International Agency and there special arrangements were made which are quite complicated, and I could send you those if you would like it.

Mr. GROSS. I hope they will not pay for it out of counterpart funds. I hope they will leave a little of the gold they have in this country to pay for it.

Mr. MCCONE. I agree with that.

Mr. GROSS. We give them agricultural products, for instance, and they set up counterpart funds. Then they could turn around and buy enriched uranium at $16 million a metric ton from us. I hope that doesn't happen. That is all, Mr. Chairman.

The CHAIRMAN. Mr. McCone, do you feel at the present time that the program in the construction of the *Savannah* is wise?

Mr. MCCONE. Yes; I think so. I think it is a wise understanding. I think that it is going to prove valuable. I think it is going to prove a means of answering a great many problems.

The CHAIRMAN. Do you think it is a proper thing for the Government to have done?

Mr. MCCONE. I think it is a proper thing for the Government to have done.

The CHAIRMAN. Were you around here when this committee initiated the bill and had hearings on the bill that brought about the construction?

Mr. MCCONE. No; I was not, sir.

The CHAIRMAN. This hearing is very similar. There was a lot of fancy footwork, private encouragement, and then public denunciation of the program that is confusing me. This hearing is very similar to it. I had some experience then that I have never been able to reconcile. But for this committee, we would not have the *Savannah*, you know that, do you not?

Mr. MCCONE. Yes; I realize that.

The CHAIRMAN. You realize that?

Mr. MCCONE. Yes, sir.

The CHAIRMAN. Maritime testified against it, at the witness stand that you are at now, and advocated the taking of an old ship and putting a reactor in it.

Mr. MCCONE. I remember that.

The CHAIRMAN. That was the program at that time. So that that is what is confusing here this morning. Your testimony is very refreshing.

In summing it up you then feel that the experience we would gather about the practicability of the *Savannah* as a passenger-cargo vessel justifies the action at the present time?

Mr. MCCONE. Yes; I think it justifies action and I am very happy it is going forward.

The CHAIRMAN. Do you have a 12:45 engagement?

Mr. MCCONE. Yes; I do.

I would be very happy to come back at any time.

The CHAIRMAN. These gentlemen here, the other members of the committee, might have something in mind.

You have been a splendid witness and an interesting witness. I appreciate very much your generosity in bearing with us this morning.

At some later time, if these gentlemen desire, we will get you to come back.

Mr. MCCONE. I would be very happy to come. It is only that, as you know, the law provides that certain hearings of the Joint Committee specified by law must take place.

The CHAIRMAN. We will have a continuation of these hearings with Maritime, Mr. Morse and his staff, tomorrow morning.

We will adjourn now until tomorrow morning at 10 o'clock.

Mr. MCCONE. I will come back at your call, sir.

(Whereupon, at 12:50 p.m., the committee adjourned, to reconvene at 10 a.m., Wednesday, February 18, 1959.)

ATOMIC SHIPBUILDING PROGRAM

WEDNESDAY, FEBRUARY 18, 1959

HOUSE OF REPRESENTATIVES,
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
Washington, D.C.

The committee met at 10 a.m., pursuant to adjournment, in room 219, Old House Office Building, Hon. Herbert C. Bonner (chairman) presiding.

The CHAIRMAN. The committee will come to order.

Yesterday the Chair announced plans to conduct an inquiry into the overall requirements of the United States in the various fields of oceanography.

Through the jurisdiction of this committee over the merchant marine generally, the Fisheries, Coast and Geodetic Survey, and Coast Guard, we have had occasion to consider separate aspects of the broad field of oceanography from time to time.

In the past year or so, however, as a result of the successes of the International Geophysical Year, the need for a coordinated study of all the various elements of the oceans has become apparent. Moreover, new concepts of transportation and of military preparedness have shown that detailed knowledge and understanding of the oceans and their contents will assume even greater importance. Despite the importance of the oceans, our knowledge of them is small when compared with the need. Recognizing that neglect in this area of endeavor might well result in our being placed in a precarious position from the scientific, technological and military points of view, the National Academy of Sciences and National Research Council decided in 1957 to form a Committee on Oceanography. This Committee of distinguished scientists under the chairmanship of Mr. Harrison Brown, professor of geochemistry at California Institute of Technology, has just released a report of its deliberations to date outlining the scope of research and survey work that needs to be done and the facilities that will be required to achieve a thorough study and maintain our initiative in this important field over the 10-year period from 1960 to 1970.

Chairman Brown and members of his Committee visited me last week to discuss their report and ways and means whereby we, in Congress, may be alerted to the importance of the subject and aid in implementing the proposal of the scientific group.

I assured Mr. Brown and his fellow committee members that we were well aware of the need of congressional and public interest in this subject and that I would initiate a study by this committee at the earliest possible date, using their report as a starting point.

Accordingly, I wish to announce at this time that I have appointed a special Subcommittee on Oceanography to review the report of the Committee on Oceanography of the National Academy of Sciences and hold such hearings and take such other action as may be appropriate in order to fully develop the extent to which we should go to carry out a broad and effective national program of oceanographic studies.

The membership of this special committee is as follows: Mr. George P. Miller of California, chairman; Mr. John D. Dingell, of Michigan; Mr. Alton Lennon, of North Carolina; Mr. James Oliver, of Maine; Mr. Gerald T. Flynn, of Wisconsin; Mr. Francis E. Dorn of New York; Mr. Thomas M. Pelly, of Washington, and Mr. Willard S. Curtin, of Pennsylvania.

Mr. Miller, I hope that you will get your committee together and initiate a program as early as possible.

Mr. MILLER. Thank you, Mr. Chairman. I assure you that that will be done because this is one of the blind spots in the whole field of science. We are in an age where it is necessary to know all of these things and this is the one blind spot that has not been tackled as yet.

I am very happy to have the opportunity and appreciate the confidence you have shown in me, and I assure you we will get right to work.

Mr. Chairman, I have to leave for a few minutes to attend another committee meeting. Before I go, I would like the privilege of making part of the record an article that appeared in this morning's Washington Post and Times Herald, relative to the program submitted by the Atomic Energy Commission to the Joint Committee on Atomic Energy concerning phases of this work in which we are interested. I think this is quite illuminating, and ask that it be made part of the record.

The CHAIRMAN. This article deals with ships.

Mr. MILLER. It mentions ships but it also mentions the fact that they are asking to build seven new reactors and the advancement that will be made in those reactors, and if they can make advancement in those reactors, and it is time to start building them for powerplants, we cannot hold back and wait until atomic energy is perfected before we start applying it to the sea. We have to go ahead and do what the Defense Department and everyone else is doing, take a calculated risk and get on with this program right now.

The CHAIRMAN. That will be placed in the record at this point.

(The article referred to follows:)

[From the Washington Post and Times-Herald, Feb. 18, 1959]

AEC SEEKS SEVEN ADDITIONAL ATOMIC POWERED REACTORS

(By Elsie Carper, staff reporter)

The Atomic Energy Commission submitted a program to Congress yesterday calling for the construction of 7 new atomic power reactors and the continuation of 20 previously authorized.

John A. McCone, Chairman of the Commission, said the program for the coming fiscal year would be the first step in the long-range objective of cutting the costs of nuclear power to a position competitive with other sources of electricity.

This can be done within 10 years in areas of this country where costs are high and within 5 years in friendly nations lacking coal and oil, he said.

CALLED "DISAPPOINTING"

The program immediately ran into criticism from Democratic members of the Senate-House Atomic Energy Committee, who found it "disappointing."

The disagreement over whether the Commission is moving fast enough to develop nuclear energy as a source of electricity seemed to indicate an end to the honeymoon that has existed between the Democratic-controlled Joint Committee and the executive agency since McCone replaced Lewis L. Strauss as Commission Chairman.

McCone was the only witness at the afternoon hearings and will testify again at 2 p.m. today. In the morning he appeared before the House Merchant Marine Committee along with Under Secretary of Commerce John J. Allen, Jr., to state that the administration has pigeonholed construction of an atomic tanker.

The administration is holding off development of the ship because of budget considerations and until technical research is further advanced, they said.

McCone told the Joint Committee that the AEC plans to speed up research on atomic reactors.

"Industry, though, will assume the primary responsibility of constructing and operating plans, with the AEC providing grants to offset high construction costs," McCone said.

"If satisfactory proposals are not received from privately or publicly owned utilities, the AEC will build reactors on AEC sites," he said.

Senator Clinton P. Anderson, Democrat, of New Mexico, chairman of the Joint Committee, said that McCone's statement marked a step forward in AEC's assumption of leadership and direction in the planning of prototype development.

AEC "SHOULD TAKE RISKS"

"But," he added, "I am disappointed in its provisions with respect to the construction of experimental prototypes, which will still apparently be regarded as the domain of industry, even for advanced concepts.

"I have no reason to reverse my own feeling that for advanced experimental prototypes the AEC should take the risks and direct the project, particularly where the Government puts up all or most of the money," Anderson said.

Senator Albert Gore, Democrat, of Tennessee, and Representative Chet Holifield, Democrat, of California, took exception to a statement by McCone that the past 5 years of AEC efforts in providing civilian power reactors "have paid off in remarkable progress."

Gore said the progress had been "miserable" and Holifield said, "I don't feel there has been very much progress."

Gore added that he was severely disappointed that a specific program had not been presented by McCone.

The CHAIRMAN. Our first witness this morning is our good friend, fine member of the present administration, Chairman of the Maritime Board, Mr. Morse.

STATEMENTS OF HON. CLARENCE G. MORSE, CHAIRMAN, MARITIME BOARD AND MARITIME ADMINISTRATOR, AND RICHARD P. GODWIN, PROJECTS OFFICER, MARITIME ADMINISTRATION, AND ASSISTANT DIRECTOR, MARITIME REACTORS, ATOMIC ENERGY COMMISSION

Mr. MORSE. Good morning, gentlemen.

Mr. Chairman and gentlemen, I have a prepared statement which duplicates to a degree some of the statements made yesterday. It will be difficult to cull them out so that, with your permission, I will proceed.

The CHAIRMAN. You may proceed.

Mr. MORSE. I am pleased to have this opportunity to appear before this committee and to report in some detail the progress which has been made to date in the Government's program for the development of

nuclear power for merchant ships and to discuss with you our plans for the future.

At present the joint Atomic Energy Commission-Maritime Administration program centers around the development, design, construction, and planned operation of the NS *Savannah*. Mr. Allen, the Under Secretary of Commerce for Transportation, has indicated to you that while the *Savannah* will be a working merchant vessel it will not be economically competitive, because of the sizable developmental costs inherent in projects of this type. The prime objectives of the *Savannah* are to provide actual hardware experience in the design and construction of nuclear-powered merchant ships, and to provide solutions to the complexity of problems associated with the actual operation of nuclear ships in international commerce.

A further objective is to provide means of developing improved operating and maintenance practices for such ships and of developing and testing improved nuclear components.

The vessel is being designed and constructed on a 39-month schedule and will be ready for initial test and operation in the spring of 1960. Since it was desired to have this first ship in commercial service at the earliest possible time, design was based on an established reactor concept requiring a limited amount of developmental work and without the construction of a land based prototype. Project requirements have dictated against including in the *Savannah* such provisions as simplified remote operation, employment of the direct cycle, bulk cargo shielding, structural containment, and onboard refueling. These are desirable design features which will make future nuclear ships more nearly competitive.

As it has been indicated, the NS *Savannah* will be a combination cargo-passenger vessel of 21,000 tons displacement, 595 feet in length, with a beam of 78 feet. She will carry slightly over 9,000 tons of cargo and have accommodations for 60 passengers. The nuclear propulsion plant will produce 20,000 shaft horsepower and a service speed of 21 knots.

Design of the *Savannah* was accomplished by George G. Sharp under contract with the Maritime Administration. Construction of the vessel and installation of the nuclear propulsion plant are being carried on by New York Shipbuilding Corp. under a joint contract with the Atomic Energy Commission and the Maritime Administration. Development and fabrication of the nuclear powerplant are being performed by Babcock & Wilcox Co. under a contract with the Atomic Energy Commission.

The nuclear powerplant is, of course, the most interesting feature of the *Savannah*. In layman's terms, the plant consists of a 74-megawatt (thermal) pressurized water reactor which supplies the energy for driving the ship's machinery. Heat obtained from water circulating through the reactor is used to generate steam in a U-tube boiler. This steam is in turn piped to the main and auxiliary turbines as in our conventional marine plants.

We believe we have been conservative in the safety features we have designed into the *Savannah*. All portions of the ship and the nuclear plant are being designed to comply with all applicable statutes, rules, and regulations of the Coast Guard, the Atomic Energy Commission, Public Health Service, and American Bureau of Shipping. The re-

actor and its shielding, together with its related components, are enclosed in a 50- by 35-foot heavy steel containment vessel. This vessel is in turn surrounded by a secondary radiation shield which includes collision mats composed of alternating layers of wood and steel. The containment vessel will be sealed at all times during plant operation and no high pressure, high temperature piping containing water from the reactor will be permitted to penetrate the containment vessel. All equipment which might fail during plant operation in the containment vessel has been installed in duplicate, or provision has been made to isolate the faulty equipment from the rest of the plant. No entrance to the containment will be permitted until the plant has been shut down and the containment plant purged. This arrangement is designed to prevent the release of radioactive material in the event of an emergency involving the vessel or its nuclear plant.

All the vessel's auxiliary systems are designed with a high degree of reliability to assure reactor safety in any phase of reactor operation and shutdown. The *Savannah's* reactor system is designed to operate safely and efficiently while encountering all the motions resulting from pitch and roll. All liquid and solid radioactive wastes resulting from the operation of the nuclear plant will be retained within the vessel and stored on board for safe disposal ashore. Gaseous wastes will be discharged through a mast after controlled air dilution.

In general, the ship's complement will be similar to that of a conventional ship of this type. All ship operating personnel will be seasoned mariners fully qualified and documented by the Coast Guard. Added to their skill will be the nuclear training necessary to enable them to assume the new duties required by the propulsion system. The training will vary in intensity and duration—engineering officers will have had 15 months of academic work, reactor simulator training, and field operation of existing reactors. The first course for engineers began in September 1958. In addition to 15 prospective *Savannah* officers, we have 2 Coast Guard officers, 2 staff members from our maritime academies, and 16 trainees sponsored by private ship design, building, and operating companies. I say "sponsored" because their tuition, salaries and expenses are paid by their employers. This is firm evidence of the industry's interest in this new mode of propulsion.

A second group of 11 engineers will start training in April so that we may have 3 fully trained reactor operation crews ready (or available on short notice) for service on the *Savannah* when tests and trials have been completed. Those not immediately assigned for *Savannah* service will be used elsewhere in the operating contractor's fleet. These engineers will, of course, provide the Maritime Administration with a trained corps from which crews for future nuclear ships can be drawn.

The captain and his senior deck officers will be more than managers of an oceangoing vessel; they will also be managers of a reactor installation. Familiarity with the system will enable them to exercise the same kind of judgment and surveillance that have made American reactor installations models of industrial safety. A 9-month course of training and observation in various reactor plants for these deck officers will be initiated in April.

Other crew members, including the ship's doctor and health physicist, will have specialized training of appropriate duration, varying

from 3 weeks to 4 months. In the future, of course, practical crew training can also be carried out on the *Savannah*.

Operating procedures manuals are being developed for the ship as a unit—not for the nuclear system alone. All major procedures will be supplemented by comprehensive checklists. For instance, the reactor startup manual will include functional checks of all safety and control equipment. Procedures for unusual operating conditions will be developed in accordance with marine emergency and damage control practices modified to reflect the unique nuclear character of the propulsion plant.

With the completion of the *Savannah* about 1 year away, we are actively engaged in our plans for her operation. Following the initial tests and trials, the *Savannah* will be operated so as to delineate the problems of commercial nuclear ship operation and arrive at their practical solutions. This will involve not only the development of the most practical and economic procedures for the operation and maintenance of the nuclear plant, but would also include identification and resolution of legal and regulatory problems, health and safety matters, and a determination of which trade routes and cargoes can be most effectively served by a nuclear ship. Our view is that the most effective way to solve this problem is to initiate the actual carrying of passengers and cargo at the earliest practical time.

I have described the *Savannah* and the operating plans directly related. There are also ancillary services and programs which have been undertaken. These will have applicability to all future nuclear ships as well as to the *Savannah*. Three broad areas of investigation and preparatory work may be of special interest to this committee: Refueling and reactor servicing facilities; the environmental health program; and the formulation of international nuclear ship rules for design construction and operation.

A mobile facility is being designed for the safe handling of new and spent fuel and accumulated reactor wastes. This servicing barge will be approximately 130 feet in length with a 36-foot beam and will be equipped to perform those services which are required to augment regular repair yard capacity.

This barge will be operated in conjunction with fixed shore facilities which will provide a temporary storage pit for spent fuel elements, storage for refueling equipment, other equipment needed for unique maintenance of nuclear plants such as clean rooms, hot repair facilities, and storage for liquid wastes. These specialized facilities, together with any existing major ship repair establishment, would be fully capable of servicing the *Savannah* and future nuclear ships.

Our environmental health program, I regard as one of the best examples of the coordination of specialized agency talents in planning for the safety of shipboard personel and harbor populations, and the protection of estuarine and ocean food resources. The Public Health Service has loaned personnel to the project; these men are working closely with the Coast and Geodetic Survey, the Weather Bureau, Geological Survey, the Army Corps of Engineers, the National Academy of Sciences, Oak Ridge National Laboratory, Chesapeake Bay Institute, and others. These groups are engaged in field and research problems of potential interest in the commercial operation of nuclear ships. This includes detailed studies of the circulatory patterns in

a typical harbor. The data obtained from these field surveys will be extrapolated to many of the harbors of the world through the use of hydraulic models operated by the Corps of Engineers. The National Academy of Sciences is currently examining the scientific considerations in determining reasonable procedures by which reactor wastes could be safely discharged into the marine environment; such a system, if proven feasible would contribute significantly to reduced cost of nuclear ship operation and construction.

The publication and dissemination of technical reports and construction progress films for use by industry have been a small but effective part of this program. You are to be shown one of the two films made. We conducted a symposium in 1957 at which we presented to American atomic and marine industrialists the early plans of the nuclear ship contractors for the NS *Savannah*. In August 1958 a similar symposium drew a thousand attendants and participants. Copies of the proceedings have been sent to this committee. Should you each desire a personal copy, I am sure that can be arranged.

Members of this committee are well aware of the complexity of laws and regulations applicable to the merchant marine—the more complex because of its international character. We want to avoid an involved situation which would arise if divergent rules are applied to nuclear ships. Several nations interested in nuclear ship propulsion have taken steps toward the formulation of rules to be applied internationally to the design, construction, and operation of nuclear ships. Plans are being made for a conference with the principal maritime nations to go over the rules which may be required.

Up to this point, I have described to you those activities of the *Savannah* and those support programs which we believe are necessary to put this ship into worldwide service.

Why are we building the *Savanah* and what are the incentives for this country to pursue the development of commercial nuclear fleets?

Let me repeat what I have said earlier. It was recognized at the time that the NS *Savannah* was authorized for construction that it would not be competitive to build or operate, but rather that enough experience would be gained in the actual construction, operation, legal, and regulatory areas to permit us to realistically design a second ship which could approach an acceptable status.

If the program for the application of nuclear power to the American merchant marine is to advance, a second ship must be built, since it is not possible to develop the full potential of nuclear power for ships through research alone. Only through the construction of full-scale prototypes can we prove research and design conclusions and actually demonstrate the value of nuclear power for commercial ship propulsion.

On the assumption that authority and funds for a second ship project were available now, it would be 2 or 3 years after the initial operation of the *Savannah* before this ship could be placed into service.

We have been encouraged by the interest of private operators in assuming certain of the costs associated with the building of nuclear ships. However, as early experience with the development of central station powerplants has shown, industry alone cannot carry the bur-

den of development. We are, therefore, convinced that the Government must take the lead and provide the impetus for advancing commercial nuclear propulsion.

As early as 1956, work was started to determine the ship-reactor combination which had the highest potential of achieving early economic operation. These studies showed that a large tanker powered by a boiling water reactor would best meet this requirement.

A tanker spends 85 percent of its time at sea as compared to 50 to 60 percent for a cargo ship. Thus, greater utilization of the admittedly more expensive nuclear propulsion system can be realized by a tanker than by other classes of merchant ships. Also, the modern trend toward larger and faster tankers tends to place the nuclear plant in a more favorable position due to the disproportionately low extra cost needed to obtain higher power.

In the Atomic Energy Commission's central power station program, the boiling water reactor has shown promise beyond original expectations. Experience to date with an experimental plant of this type has demonstrated that it can be safely operated at greater than twice its designed capacity. Several land-based plants of this type are already operating and others are under construction. These plants will provide a substantial amount of additional technical information. It, therefore, appears that a boiling water reactor can be installed in a merchant ship with limited expenditure for research and development and without the construction of a land-based prototype. Some engineering development is necessary to adapt this type to marine purposes. Engineering work was started in 1957 by the Maritime Administration and the Atomic Energy Commission to resolve the major problems imposed by seagoing operation. This work includes pitch and roll problems, design and development of appropriate seagoing auxiliaries, design of containment and shielding and of fail-safe reactor controls, together with a preliminary ship design.

The boiling water reactor system has several characteristics which make it of great interest for merchant ship use. The boiling water plant appears to be more compact and lighter than the pressurized water type used in the *Savannah*. Its capacity in regard to rate of load change is suitable to the maneuvering requirements of a merchant ship. The physics of the boiling water system are such that it is almost self-regulating and, therefore, it does not require an elaborate control system.

I have referred several times to the interest displayed on the part of American merchant marine and nuclear industrialists. They are in full agreement that we cannot pioneer with one reactor type in one passenger cargo vessel. The *Savannah* will enable us to solve many practical problems and pave the way for general acceptance of nuclear shipping; it cannot answer the specific economic questions raised by builders and operators of tankers, ore carriers, large passenger ships. What we now must do is get on with the construction of a ship which probes the economics of nuclear propulsion. This is something that continued research and development cannot do.

The acceptance of nuclear power by commercial operators will be on the basis of economics. We know that operational efficiency and economic operation cannot be achieved by the building of one or two nuclear ships. We must approach competitiveness in a step by step

program aimed at solving the technical and operating problems. Private industry has indicated its desire to participate in the development of nuclear engineering in concert with the Government. However, under existing maritime laws, such a cooperative program is not possible. We have made recommendations that legislation be prepared which would help private industry to defray the difference in costs between a conventional and a nuclear-powered ship. Here again, if such legislation were enacted, considerable time would be required to solicit and receive and negotiate a contract with private operators.

Essentially all of the major maritime nations have active nuclear propulsion design and study projects in progress. The Netherlands has a small tanker in planning stages and the United Kingdom has advanced engineering underway for a fleet auxiliary tanker. While we know of no commercial nuclear propulsion project which has entered the construction stage, several countries have advanced to the point where this could happen at any time. It should be recognized that much of the nuclear information used by these countries was developed in the United States.

We can lose our leading position if we fail to take advantage of American industrial capability. Private industry has the capability but not the economic incentive to pursue it. This incentive must be provided temporarily by the Government. A cooperative development program can exploit the capabilities which are not latent and can assure the retention of the merchant marine leadership of which we are so proud.

Such a program would be relatively simple. The Government's share might be the difference between conventional plant costs and the costs of development, construction, and initial operation of nuclear plants. The technological advances made in that program will be available to the cooperative program—thus lessening the time and money required to reach our goal of an efficient and economic nuclear merchant fleet.

Gentlemen, I have with me today Mr. Richard Godwin, who is head of the Nuclear Projects Office. He is a man that wears two hats. He works in Maritime and he is on the AEC payroll, but he is the man who will be able to answer most of the technical questions which you may raise.

The CHAIRMAN. I understand.

Have you finished?

Mr. MORSE. Yes, sir.

The CHAIRMAN. Does Mr. Godwin care to make a statement at this time?

Mr. GODWIN. I have a briefing statement which I would like to present, but it is arranged at the present time to follow Mr. Morse. It is a briefing of the program rather than a statement such as Mr. Morse presented.

The CHAIRMAN. Is it the suggestion, Mr. Morse, that we look at this picture at the present time and then go into any questions?

Mr. MORSE. We had it set up that Mr. Godwin's activity would follow any questions that you care to make, but we can adopt any procedure you would prefer.

The CHAIRMAN. Would it be better that we go into the picture feature and then ask you any questions about this later?

Mr. MORSE. I think it would be more real in your minds to see what we have actually done and see the pictures and some of the charts.

The CHAIRMAN. Then we will proceed with the pictures.

Mr. GODWIN. The picture itself is not presented alone. We have for the committee a briefing of the program. The program is somewhat broader than the picture, which is aimed specifically at the *Savannah*. If we may, we would like to present to you a briefing of the organization to do the job, the program as it is set up, the background, some of the major technical problems, and then show the film, and discuss briefly some of the charts for advanced systems that we have here today to display.

The picture, as I say, does not stand alone.

The CHAIRMAN. You go ahead with your program as you have arranged it then.

Mr. GODWIN. As I have said, I am here today to present to you a briefing on the technical problems which are associated with adopting nuclear power to the merchant marine and, time permitting, I would like to also describe some of the problems which we face in developing new plants and adapting new concepts as they are brought into being in the Atomic Energy Commission program.

The CHAIRMAN. Mr. Godwin, will you identify yourself for the record?

Mr. GODWIN. Mr. Morse did identify me.

My name is Richard P. Godwin. I am nuclear projects officer for the Maritime Administration. I am Assistant Director for Reactor Development, maritime reactors, of the AEC.

The CHAIRMAN. What is your previous background?

Mr. GODWIN. My previous background before joining the AEC, which I have been with for 8 years, was as a metallurgist in private industry for a period of 6 years.

Prior to that I was a naval officer for a period of 4 years, in which my background in ship construction was obtained, before that I was a graduate of Yale University where I did my undergraduate work, and did some graduate work at Washington State University.

The CHAIRMAN. Proceed.

Mr. GODWIN. Previous witnesses have discussed the NS *Savannah* and her progress. Reference has also been made to the supporting programs, which I would like to also describe in some greater detail here.

All of the work which we have described falls into three major categories: First, applications of technically proven reactor systems into essentially conventional ship hulls. The *Savannah* is the best example of this. The PWR is a reactor which was developed for the Navy. We have attempted to redesign and reengineer this particular system for commercial application.

The ship hull in which the reactor rests at the present time is a maritime-developed hull. It is not of an advanced design in that it doesn't depart significantly from present engineering practices.

The second portion of the program which we are pursuing is the development of economic, compact, lightweight plants for future application to the merchant marine. These are plants which have signifi-

cant departures from anything that has been built to date, and one step further in this same area is to look into ship design as we presently know it to come up in a period of 2 to 3 years with hull designs and hull concepts which could best utilize nuclear power in the merchant marine. By this I mean to include specifically such great departures as possibly the submersible tanker, seatrains, and ship hulls which are designed to be adapted to nuclear powerplants. By this I mean that the ship's hull would be greatly strengthened. In the ship's hull we would build the containment features which are so necessary for nuclear plants. We would also build into the ship's hull shielding which is necessary and use cargoes in the tanker case for these shielding purposes.

Finally, the third portion of the program is that work devoted to resolving the myriad problems associated with operating these plants in domestic and foreign commerce.

I will touch on this briefly.

Before I proceed, if you would permit me, I would like to outline what our situation is as far as nuclear energy is concerned in its application to nuclear ships.

First of all, the problem with conventional fuels is that we face a picture of rising fuel costs and a decreasing availability.

The rising fuel costs at the present time lead us to use sources which are not easily available to us. This aggravates our logistics problem. The cost of tranporting fuel from the Persian Gulf also aggravates our present fuel picture.

Thirdly, all of the present systems for powering vessels or, for that matter, powering any of our vehicles used today, are air breathers. To run these vehicles we require air, which opens the system, discharges noxious fumes, and various other kinds of materials. Finally, as far as the fossil fuel plants are concerned, we have about come to the point where any further gains in terms of efficiency are going to be hard won.

We have squeezed out the easy gains. We are now working on small percentage gains.

Efficiencies in these plants of 25 to 30 percent are considered very high. We are very fortunate to get that. We have now in front of us a changing picture. About 15 years ago, with the advent of the atomic age, a new energy source appeared on the scene. Nuclear energy, of course, is not a cure-all. It is a very expensive business. Basically, what we have now with nuclear power is a tremendous power source which can be condensed into a very small volume. The only reason we cannot build powerplants which are very, very small or, you might say the size of a basketball, is the fact that we do not have materials at the present time nor the methods to carry away the heat sufficiently to do the job. So we have to drop back to something which is a compromise between what we would like to build and what we can build within existing technology.

Therefore, our job is also one of trying to be efficient in the use of the neutrons which are generated in a nuclear reaction.

We also would like to carry away the heat in an efficient manner, and a safe manner, of course, and pervading through all this is the desire of the merchant marine to build plants which can operate under all conditions with people who are not, you might say, scientists,

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who can operate these plants, and have these plants fail safe. Mr. Morse referred to that. By this "fail safe" statement I mean that no matter what an operator does to the plant, the plant would tend to shut itself down rather than to run away.

This, then, in a nutshell is about what our job consists of, working with the materials we have and carrying away and using the heat in an efficient manner.

Now, I have with me some slides this morning, and if the projectionist can show these slides rather than the picture, I would like to show five slides which very briefly can, in a pictorial sense, give to you the point I am making here. Is this agreeable to the chairman?

The CHAIRMAN. Yes.

Mr. GODWIN. While they are getting things set for the first slide, we should look at the present situation as this: we now have a new method of utilizing heat from the atom itself rather than the combination of atoms such as in the chemical heat source.

While we have these materials in a very small, compact arrangement, we have to be sure that the materials which keep it going, in other words, the neutrons, are utilized or reflected back into the reaction.

May I have the first slide, please?

This slide shows in a very simple form, a chain reaction. It demonstrates that if we run one neutron into uranium 235, that the 235 will fission and in fissioning the uranium gives off two plus neutrons and splits into two fragments.

In that first slide the whole story of adapting nuclear power to the merchant marine exists.

First of all, we have no choice but to use neutrons. We have to use these. These are the tools we work with.

Second, the two fission fragments are the things we worry about. These are the nuclear ashes which result from nuclear reaction and it is this radioactivity or nuclear ashes that the whole problem of design, containment, and safe operation of the plant revolves around.

You will see in the middle of the picture the rectangular form, which is the moderator. The moderator in the nuclear reaction is the material which causes either an efficient operation or an inefficient operation.

The neutrons passing through the moderator are slowed down, and only neutrons which are slow result in the fissioning of 235. In the particular system which we have in the *Savannah*, we use water as moderator. The reaction requires water to keep going, so that the loss of water generally will slow down the reaction. The final slide shows that this particular reaction wil continue if in fact we have enough material to form a critical mass.

May I have the next slide?

This, I think, is oversimplifying, but, basically, to get any kind of reaction we need a certain amount of uranium 235 to form a critical mass. While we can get a critical mass in this case we cannot carry away the heat or slow the reactor down sufficiently to work for us.

This next slide is about as simplified a version of a reactor and its power system as we can get. We have on the left a large pot. In this large pot we insert our critical mass. This mass is just enough to sustain a chain reaction.

In this chain reaction we get neutrons and we get heat so our job is to contain the neutron and carry away the heat. To do this we pump water through the pressurized system. In the *Savannah* that is about 8 million pounds per hour. We carry the heat away to a heat exchanger which transfers heat to a secondary propulsion system which is identical to ship powerplants presently in use.

The next slide. We can simplify this system by going to the boiling water reactor. This is the system we are proposing to build into a tanker. You will note in this slide we also have a pot on the left. In this pot we have uranium again and our problem is again one of carrying away the heat. In this case, however, we let the pot boil. In other words, there is the accumulation of steam right in this pot and we carry the steam away directly to power system. This as far as a ship is concerned, eliminates heat exchangers, eliminates pumps and presents a very quick and easy way to significantly reduce costs without devoting significant time and effort to development.

The next slide. As you can see, we can take this same approach with other reactor types and make changes and get more efficient operation. It is also axiomatic that the higher temperatures we can operate at, the more efficient the plant can be.

There are three obvious things one can presently do. The first system at the top of the slide is an organic moderated reactor. Instead of using water we would shift the moderator to kerosene or gasoline where there is a high content of hydrogen. This material would also slow down the neutrons, but these organics boil at a much higher temperature than water. Therefore, we can reduce the thickness of the pot in which we carry the uranium by reducing pressure. All the components of the primary system instead of operating at 2,000 pounds per square inch can now operate at about 35 pounds per square inch. Instead of a pot maybe being 7 or 8 inches thick of steel, lined with stainless steel, we can operate with a pot which is 1 or 2 inches thick.

The second thing which would be obvious is to use a working material with a higher boiling point than that. So we go to liquid metals. In the case of liquid sodium where, instead of boiling at 215° F. as in the case of a water or organic around 790° F., we can go to sodium which raises the boiling temperature one step higher to the point where we would boil at possibly around 1,200° to 1,500° F. Each of these plants hopefully will become more efficient as we move up the temperature range.

Of course, the last example uses a new material which is gas and you will hear more about our work on the gas system.

This system permits us to have a pot but instead of boiling anything or using a material such as liquid metal or a liquid organic we use a gas which is in the gaseous phase throughout the cycle.

I think that completes the slides I have here for this particular segment of my talk.

That, in a very brief set of words, is essentially what we are trying to do. We are trying to get to high temperatures. We are trying to be efficient and we are trying to keep costs down.

I think this is probably a good place to introduce the *Savannah* at the point where our present technology permits us to put a reactor to sea.

Now, we have passed out to the committee what we call a data book. I think all of the members of the committee have this. The data book was rapidly gotten together and we are sorry if it is not quite complete.

In this data book, on the first page, you will notice the schedule for the *Savannah* which was referred to earlier. You will note that the work essentially was started in April of 1957. We hope to have a ship in service or capable of operating on the oceans in the spring or summer of 1960.

There are a number of significant steps which we have gone through and, in the motion picture which we will show shortly, you will see the status of the *Savannah* up to the present time.

Now, also on the following pages in that data sheet, you will notice an MSR chronology. The MSR means the merchant ship reactor. This is some greater detail on the progress to date.

The pages following are the detailed characteristics and statistics of the ship and the reactor plant. I will not go into these at length except to probably refer to these as we go through the next set of slides.

Now, if I may, I would like to have the next series of slides with which we can rapidly go through the general design of the *Savannah* plant and the operating features which have been built into it.

Here again I should point out that the schedule for the *Savannah* of 39 months is the shortest development and construction schedule for any major reactor yet built in the United States, on land or sea. This is very important in the sense that we could not do all those things which we would normally want to do with an extended schedule.

May I have the first slide, please? We did not intend to go quite back this far. This happens to be the original *Savannah* built in 1818. This particular ship was 300 tons. I think the significant feature is that they required 75 tons of coal to power it and about 20 cords of wood. I think it was the logistics of the fuel which make the application of steam to sailing ships look particularly unattractive at that time.

This is the *Savannah* and it is shown here principally to permit a brief comment on what nuclear power has done to the appearance of the ship.

The two significant changes which are readily apparent are the lack of a stack and the location of the superstructure. The location of the superstructure was determined by the location of the reactor. Since the reactor requires a great deal of shielding and is a very heavy portion of the ship, it was located essentially amidships and the superstructure located immediately aft which permitted us to minimize the amount of shielding required for the reactor.

The next slide is another view of the *Savannah*. Just forward of the superstructure you will see a hatch. This hatch leads to the reactor compartment. The hatch is airtight and is a second barrier against the release of any kind of radioactive materials, steam or otherwise, from the primary system.

The next slide. This is a side look at the ship. The significant features of the ship, as you have been told, is that it is 595 feet in length, has a 78-foot beam, the powerplant is located essentially amidships and in this picture you can see the general arrangement of the containment vessel.

You are now looking at the shipstructure amidships at the containment vessel in which all of the reactor and its primary system containing radioactive materials is housed. Its size is determined not only by the physical size of the reactor equipment but also by the pressures which might be generated under the worse conditions resulting from the release of energy in the reactor coolant. Therefore, you might say it is sized to contain the maximum credible incident that might occur to the reactor.

The next slide. In this slide you get another view of the reactor. Here again the significant thing to note in the bottom picture is that the containment vessel is about 55 to 60 feet long. The propulsion equipment space is something in the order of 60 feet. In total, the requirements for the reactor and propulsion equipment are about 115 feet as compared to a conventional ship of this size which would be something in the order of 70 feet.

It should be pointed out, however, that in the *Savannah* case that outboard of the reactor and machinery compartments there is space to carry cargo such that in the final analysis the *Savannah* will be able to carry slightly more cargo than a conventional ship.

The next slide. Here is a simple schematic of the *Savannah's* powerplant. To the left is the pink pot again which contains the uranium. In the pot you will notice that we have yellow fuel elements. This is the source of the power. There are two coolant loops equally designed to carry off heat, such that if one goes out the other can be used. This system in red is the primary system, and all of this system is in the containment vessel. This system gives its heat to the blue line arrangement. This is the secondary system and there is no radioactivity in that particular system at all. The secondary system is all outside the containment vessel and it is composed of essentially conventional maritime propulsion equipment. The people who normally work on the ship are quite familiar with it.

The next slide. This is a closeup of the containment vessel and the primary system on the *Savannah.*

The boilers which look like spiders are to the right and left of the reactor. The reactor is in the center, as you can see, and rising above it are the control rods which you will get a closer look at later.

In toto, this plant, plus its containment and its shielding, will weigh something in the order of 3,600 tons.

We think, and this is for comparison purposes, that with a tanker on the second ship that we can reduce this weight for the same sized plant to about 2,200 tons. In other words, we can reduce plant weight by something in the order of 1,400 tons.

The next slide. This is a closeup of the reactor. The fuel is in the center or the bottom portion and is a silver color. Rising above the fuel are the control rods. To understand the reaction, when you get a critical mass, the problem is not one of keeping the reaction going.

The problem is one of shutting it down or controlling it, so what we do is introduce into this mass of uranium materials which absorb neutrons. In this particular case in the *Savannah* we used boron. Boron has a high affinity for neutrons, and by raising and lowering control rods, we can speed up or slow down the reaction in the core. Rising above the core you can see the control rods and these rods rise something in the order of 12 feet above the reactor.

The height of the reactor is something like 26 feet and its diameter something like 9 feet.

The reactor is designed for a pressure of 2,000 pounds per square inch and it is operated at about 1,750 pounds per square inch.

The next slide. This is a schematic of the reactor again. The cooling water, 8 million pounds per hour, comes into the bottom portion of the reactor. It flows up the outside, down through the outer fuel elements and up and out through the center portion of the core. The center portions of most cores are the hottest areas. Therefore, we have a fairly straight line relationship of temperature to passage. The temperature of the water as it leaves the reactor is something in the order of 524° F. and a pressure of something in the order of 1,750 pounds per square inch, as I have said.

The next slide. Here is a picture of the fuel of the future. We have one on the table here. I will show it to you when the lights come on.

In this fuel element, of which there are 32, we have enough fuel in the *Savannah* to power it for something in the order of 3 years. We initially introduce into the *Savannah* about 312 kilograms of uranium 235. After 3 years we burn only about 60 kilograms and return about 250 kilograms. We have to invest enough material to get a critical mass, but we do get a credit back in the form of uranium to be reprocessed and we also get at the same time some plutonium which is generated when we convert uranium 238 with neutrons to plutonium 239.

The next slide is a cross section of the reactor core. Here again you can notice the 32 fuel elements in the center. The dark crosses are the boron control rods. This is merely to give you an idea of the configuration. Outside of the fuel elements there is the pressure vessel. Outside of that there is primary shielding which is composed of lead and water in various forms to cut down the radiation from the reactor, such that crew members can enter the containment vessel, something in the order of 20 to 30 minutes, after the reactor is shut down. The time of entry is almost completely dependent upon the decay of activity in the primary system and the shielding which is around the reactor vessel which you see here.

The next slide is a picture of the console for the *Savannah* and this is the heart of the powerplant and for that matter the heart of the reactor and all of the other systems in the *Savannah*.

This is the part of the job that the crew will find new. This power panel on the left has all the manual controls for the control rods.

The left corner section has the controls for the pumps and purification system.

The center portion is the active portion of the plant. This controls the power level, the location of the control rods on automatic and is the part of the console toward which the operator will maintain constant vigilance.

The right side has the electrical systems, and the panel on the far right at the present time is set up to take other hotel load indicating instrumentation.

The next slide is a cutaway of the *Savannah*, which shows the reactor to the left in its containment vessel and also shows the foundations. There is some activity outside of the primary shield and there-

fore we must add on a secondary shield which consists of about 4 to 6 inches of lead with an equal amount of polyethylene. This is outside of the containment vessel and reduces the level of activity on the ship for passengers to essentially background. In other words, the passengers on the nuclear ship will be exposed to activity probably not higher than what they would receive if they were walking down the street.

I think the only other interesting feature here is the skirt around the containment vessel. This is a shield but at the same time it houses a collision resistant mat. We are conducting fairly comprehensive studies on all the ship accidents that have taken place to date and we find that the *Savannah* would have been resistant to essentially all collisions which we have studied to the point where a ship would not penetrate into the *Savannah* to the containment vessel. The ship's hull has been strengthened in this area and we feel its resistance is higher probably than any merchant ship afloat today.

The next slide is another cutaway. Again it just shows the ship with a cutaway of the reactor.

There are two things I would like to point out: First, that the *Savannah* is a prototype. In other words, we have never built a plant like this before. We are not building a plant in the desert as is normally practiced for other nuclear seagoing vessels and the *Savannah* will be on a short production time schedule.

Now, I think we have probably set the stage for our status report on the *Sanannah* and, if it is all right with the chairman, we would like to show the motion picture at this time.

The CHAIRMAN. I would like the record to show that we have a very distinguished Member of the House and former member of this committee present, Mr. Shelley, who is greatly interested in maritime affairs. We are glad to have you, Mr. Shelley.

(Motion picture shown.)

The CHAIRMAN. On behalf of the committee, I would like to say that the picture was interesting and most informative.

We appreciate your showing it.

Mr. GODWIN. You are welcome.

I might say here that in terms of percentages the development of the *Savannah* reactor is about 90 percent and its fabrication is 35 percent complete.

The ship outfit is 30 percent and the hull of the vessel at the present time is 40 percent completed, as you could see on the screen.

In addition to building the *Savannah*, which we are presently involved in, we have initiated a program to carry out the President's desire that the *Savannah* be a floating laboratory. In this program the *Savannah* plant would be upgraded so that the latest in techniques and components will be available during its useful life. Certainly the most important of these features in the *Savannah* and the features which will determine costs to a great extent are those factors which are built into the fuel.

On our left here, you can see a fuel assembly for the *Savannah*. Four of these assemblies make one element. This element then is located in the reactor and 32 of them will represent 3 year's fuel for the *Savannah*.

The uranium is inserted in the top of these stainless steel tubes. This exhibit component is one of the early test pieces.

For Mr. Miller's benefit, I will mention that we have built a number of these elements and they are now in the Vallecito reactor in California undergoing radiation tests. In other words, we build and test them before we install them in the ship to see that they operate properly.

These elements have been in the Vallecito's reactor for something like 5 to 6 months. We will continue to irradiate these elements until the ship goes into service.

As far as other components are concerned, we are primarily concerned with the simplification of these nuclear plants. Early in the life of most technologies there is a great tendency toward complicated safety mechanisms. There is an overstress possibly for surety, reliability and flexibility to improve performance.

Our first job, of course, is to build out this flexibility but build in simplicity. The *Savannah* upgrading program will last probably 4 or 5 years after the ship is in service to make it a truly marine plant.

If I may, I would like to refer to some of the charts which you have in your data books and one I have here which I did not show earlier.

This chart represents the organization that we presently have to carry out the maritime program. As you know, the Atomic Energy Commission under Public Law 848 was given the job of building the reactor and the Maritime Administration the principal job of adapting this reactor to a ship and creating a world environment in which nuclear ships could operate. The two agencies formed the Office of Nuclear Projects which took people from both agencies to carry out the building of the *Savannah*, the support programs which were necessary for its backup and research and development aimed at low cost nuclear plants of the future. This represents the organizational arrangement of the group at the present time.

I might just briefly mention here, as far as support programs are concerned, that we have probably 20 or 25 major programs in being but, for the purposes of the committee, I will only touch on a few, some we have referred to earlier.

The environmental work we have considered as being very important. The primary purpose of it is to determine the conditions of our harbors at the present time to determine the flows of air and water and try to establish the level of activity that presently exists in these harbors. From these we will develop site surveys which are specific surveys of particular facilities in the harbor and locations from which we can arrive at the most appropriate operating arrangements for the *Savannah*.

The harbor surveys and site surveys then lead to countermeasures and emergency procedures in the event that the ship experiences any kind of emergency operation while in port.

A second major program in this area is ship design criteria. As I mentioned, we have gone back and have studied accidents that have happened to ships of over 4,000 tons that have occurred in the waters of the United States for the last maybe 5 or 10 years. From that we are developing design criteria which hopefully will render these ships more resistant to fire or collision.

We have looked into a number of these things and are now attempting to come up with designs which will present a ship at minimal cost which will do the job and be as safe as we can possibly build at the present time.

The other portion of our work, which is the operations portion, I will show on the next chart. We have a big problem of coordinating with the Coast Guard, the Public Health Service, the American Bureau of shipping and the AEC, acceptable standards for the reactor and its components and the insertion of these components into the ship's hull. This requires a great deal of time.

It should be pointed out, as Mr. Morse mentioned, that every print and plan which has been developed for the *Savannah* has been given to the Coast Guard and to the American Bureau of Shipping and to the Advisory Committee on Reactor Safeguards in the Commission, and thus it has been necessary to bring the industry along with us in the construction of the *Savannah*.

We have had an educational program in being from the very beginning. The development of codes of regulations here in the United States and the education of the public as to what nuclear ships consist of have been a major portion of our program.

I should also say that we are in discussions with counterparts to the Coast Guard, Public Health Service, and American Bureau of Shipping in other countries, principally the United Kingdom.

The United Kingdom is sending a representation to the United States next week to discuss general operating ground rules for nuclear ships. If agreement is reached, we will have overcome a major obstacle.

The portion that was left off of this chart, which is in the category of operations consists of crew training to which we have referred, the building of mockups which you saw in the motion picture, simulators, and the various academic training courses necessary for crews.

We have to develop operating procedures at sea, in ports, and refueling, which I will touch on briefly in a few minutes.

Unfortunately, with the building of one ship, the United States has to buy its way into the nuclear ship business. By building the first ship, we have to provide capability around the world to service the *Savannah* under any conceivable set of circumstances.

Therefore we have developed what we think is a fairly high level of mobility in all of the services required for the *Savannah*, such that any large shipbuilding or ship servicing facility can in fact service the *Savannah*.

On this particular chart, you see the *Savannah* with a servicing barge which is alongside and this particular barge is a facility which would handle all the radioactivity. Radioactive wastes on the *Savannah* would be pumped to the barge, the liquids would be purified. Other equipment would be stored on the barge and transferred to normal Atomic Energy Commission facilities for later disposal. This barge you see here, plus the lifting equipment, which shows on this slide, is about all that is necessary to service the *Savannah* beyond what is normal or a regular shipyard might provide.

Here is the schematic of the fuel cycle which this committee may not be able to see clearly. There is in your data books a diagram

which is identical to this. This merely represents the transfer of fuel by a lifting barge to the servicing barge which we are building, transfer from the servicing barge to shore facilities, the eventual reprocessing of the fuel and the return of the fuel to the ship. In other words, when we install 312 kilograms in the *Savannah* next January, we will operate the ship for 3 years, and then have a credit of 250 kilograms of unburned material to run through the steps shown here.

I will just briefly touch on the advanced systems. I do not know how much time you would like to devote to this subject on which we could spend several days.

Let me just go on rather quickly to the features of a boiling water reactor which we might build into a tanker.

First of all, the question arises, why build a boiling water reactor? As I mentioned to you earlier, the boiling water reactor is basically a simpler system. It is demonstrated to be reliable. We have two plants in operation on the land now and we have several under construction. The costs of these plants, we believe, are significantly less. Our present estimates for a boiling water reactor plant for the tanker of about 30,000 shaft horsepower, which is 10,000 SHP more than the *Savannah*, would run something between $10 and $12 million. This is the total plant, including the propulsion equipment.

I should also say, that this is somewhat higher than a conventional plant which would run probably about $4 million.

However, this figure has to be compared then to the *Savannah* plant which at the present time is running between $16 and $18 million. All of these costs include the research and development which is associated with it and the work necessary to build the first-of-kind. In other words, all the engineering is lumped into these figures.

Any nuclear ship first-of-kind built at any time, whether we build it at the present time or whether we build it 15 years in the future is not going to be economical the first time simply because all the costs of engineering are applied to the first vessel. This would certainly be true of a new model car in any one year. In the boiling water system we also suffer from this.

We feel that the cost of a second plant like this would be reduced to between $6 and $8 million, which would be substantially less.

Beyond the question of reduced capital costs, which we hope to realize over a period of time, we would also be able to make significant savings in space. The space considerations on ships are very important but in the case of a nuclear plant it is more important because space for the plant adds up to the size of containment which we would probably build around the reactor system. This would indirectly lead to the necessity to add larger amounts of secondary shielding which are very, very heavy. Thus the smaller the plant the smaller the containment and indirectly the lighter or smaller the shield.

This all leads to a greater earning capacity for an individual ship.

Also, the boiling water reactor has negative temperature coefficient of reactivity which means the more you try to raise the reactor's power the more the reactor tends to resist. There is a safety feature here, which is also true for the *Savannah*. The reactor is, you might say, inherently safe in terms of load.

As far as the tanker is concerned and the reason we would build a boiling water reactor on a tanker is that savings in weight on the

tanker can be directly utilized to carry more cargo. This is not necessarily true for a passenger-cargo or cargo vessel. Also, on the tanker we can use the cargo itself for shielding which has two benefits. We do not have to build this shielding in the first place. Thus it reduces the capital cost, and secondly we can carry more cargo. Also the tanker is at sea, as Mr. Morse said, for probably 85 percent of its operating life and the tanker generally operates between remote sites.

The question of entering populated ports is not so important as far as tankers are concerned. The nuclear tanker can operate at higher sustained speeds because we do not have to pay a higher incremental cost for that additional amount of power which is required to get higher speeds as in the case of a conventional ship.

We can now show some slides on the boiling water reactor which I think will demonstrate fairly quickly what I mean with respect to simplicity of design.

This is the flow diagram for the boiling water reactor. You saw it initially in a more simplified version but this plan is also generally simple and it has a high degree of efficiency.

The next slide, please.

Here is a model of a boiling water reactor in a tanker. You will note the size of this particular system as compared to the *Savannah*. This particular plant is exactly the same power as the *Savannah*. You will notice that it is in the forward section here. It stands vertically in the vessel as contrasted to horizontally in the *Savannah*.

We have found this to be significant in terms of weight and space.

The reactor, however, does produce saturated steam which is not the ideal situation for these powerplants. It also requires that we build in significant amounts of shielding.

The next slide. Here is another view of the same reactor. This demonstrates that, unlike the *Savannah*, which must come into port to a facility which is fairly complete to refuel, the boiling water reactor, chances are, can change fuel with on-board equipment. In other words,we would have need for no extra shoreside equipment.

I think Mr. Pelly yesterday raised the question as to whether or not it would take significant amounts of time to refuel ships of this type.

With the boiling water reactor, we feel we can do this relatively quickly employing ships equipment and without keeping the ship out of service for any appreciable period of time.

The next slide: This happens to be the gas-cooled system which I will just touch on briefly. Before I do, in your data sheets, you will notice the costs which are associated with the boiling water reactor. They represent comparative tanker operating costs in 1958. This is the cost situation as it presently exists.

You will notice that "A" is a conventional tanker and the costs associated with it are significantly lower than any nuclear ship which we can build at the present time.

"A" is the conventional tanker. "B" is the boiling water tanker and "C" is the pressurized water tanker. These are capital costs on an annual basis, including amortization.

The significant point is that the nuclear tanker will carry more cargo than the others and when you get through sorting all the economics of the system, you will find that a conventional tanker today

will probably carry cargo from the Persian Gulf to our Jersey coast for about $11.40 in a ship built in the U.S. and operated under American flag.

As far as the boiling water reactor is concerned, it will be $12.40. The point involved here is that it will carry more cargo. A tanker with a *Savannah* type powerplant would carry cargo at $14.80. This is for a tanker with a nuclear core which we could build this year.

We have every reason to believe that nuclear fuel costs will decrease and that this factor should improve considerably over the life of the tanker.

Here is a projection of the fuel cost picture as we presently see it. This is also for a tanker. At the present time, in 1959, fuel costs are somewhat higher than conventional fuel costs. A question on this point was asked yesterday. The difference is between 3.4 mills per shaft horsepower-hour for regular fuels and 3.8 mills per shaft horsepower-hour for nuclear fuels on the same basis.

The point is that by 1965 or so we expect nuclear fuels to cost about the same as fossil fuels. Thus in the life of the tanker we would hope to have a second or third core loading cost almost identical to fossil fuels with every hope that these costs will continue to drop, as Mr. McCone stated yesterday.

This is a chart which points out the weight situation. The middle line is the pounds per shaft horsepower for a conventional plant plus its fuel. You will notice that it is about 450 pounds/shp, the conventional A and B, includes the fuels for the Persian Gulf round trip bunkered on one end and bunkered on both ends. The point is that no matter which way it is bunkered the nuclear boiling water reactor is still less in terms of weight per shaft horsepower.

That is essentially the picture on the boiling water reactor. The only other thing I would like to mention this morning would be the gas-cooled reactor, which a number of people have referred to.

As I said, the real future in terms of nuclear commercial propulsion revolves around our ability to get high temperatures and thus high efficiencies working with materials which are generally nonradioactive to reduce shield weights.

We started a program in 1957 as a result of feasibility studies which showed that the gas cooled reactor closed cycle turbine was the powerplant which, over the long run, would result in the smallest plant, the most economic plant and probably the simplest plant for commercial marine applications.

We have a diagram on the far wall which depicts essentially the size of this system as contrasted to the other systems which you have seen.

I have one or two slides, but I think we will pass over the slides to save time, and merely say that the gas-cooled system has, from an operating standpoint, a number of important features: (1) It operates on helium, and helium, of course, does not have any induced radioactivity, unlike water. Thus we are working with a medium which does not require significant amounts of shielding for normal operation. This reduces costs for the secondary shielding and indirectly the costs of containment.

You have in your data books a comparative tanker cost analysis for the gas-cooled system. This is an estimated comparison of costs for

a series of ships, but you will notice that as far as an advanced system is concerned for a gas-cooled reactor, that it will probably produce in 1968 operating revenues which will be significantly better than a conventional ship.

Again this is a pie in the sky. We have not developed the system. We are actively engaged in design and development. We have built into the Hanford reactors a gas loop which is essentially a simulated in-pile operating condition for our fuel elements.

The General Atomics Division of General Dynamics has a contract from the Atomic Energy Commission and Maritime Administration to design and build this plant as a land-based prototype. We can expect operating experience from this system in 1963 or thereabouts.

I think that concludes my briefing.

The CHAIRMAN. Thank you very much.

There may be some members of the committee who have the ability to ask you questions. I do not know. If there are, we will throw the matter open to any member of the committee now who wants to tackle this young man.

Mr. GARMATZ. I have several questions.

The CHAIRMAN. All right.

Mr. GARMATZ. Mr. Allen said in his statement, "yes" and "no" and "there was a question of whether financing would be arranged."

Mr. McCone said yesterday, if I am correct, that he thought we should wait a while, several years or so, before we started another ship.

Now, today Mr. Morse says on page 10:

> If the program for the application of nuclear power to the American merchant marine is to advance, a second ship must be built.

Also on page 13, he says:

> What we now must do is get on with the construction of a ship which probes the economics of nuclear propulsion.

"Yes, no, let us wait," and "if we have the money."

What would be your thinking on another nuclear ship, tanker, or cargo and when?

Mr. GODWIN. Is this question addressed to me or to Mr. Morse?

Mr. GARMATZ. It is addressed to you, Mr. Godwin.

Mr. GODWIN. Well, from a purely technical standpoint I would say that we are in a position now to move into the project stage on a boiling water reactor for a tanker, probably this year, possibly in the summer.

It depends, of course, upon our continued success in the development end.

Personally, of course, and again from the technical end, it would be highly desirable to prove out our work over the last several years as to whether it is in fact as good as we think it is. Whether we proceed or not depends upon a number of factors which, of course, I am not in a position to evaluate, dealing with costs and other projects which are competing for the same dollars.

From a technical standpoint, I think the answer is "yes," I think we could proceed into the project stage.

Mr. GARMATZ. You say "we could." Do you think we should? I mean from the overall picture.

Mr. MORSE. I have no hesitancy in answering that.

I personally think we should.

Mr. GARMATZ. One says "yes" and one says "no."

The CHAIRMAN. I believe Mr. Morse has answered the question for the witness.

Mr. MORSE. I think we should, Mr. Garmatz. I am not saying that we should build a ship, start from scratch today and lay the keel today. I think we are doing some preliminary design for a ship with boiling water reactor. We are doing it in Maritime, so that we are not going to the expense of outside contractors for that, but we are doing it and we think it is feasible. We think we should move ahead in this field and have urged that right from the start.

Mr. GARMATZ. If I understand you right, did you say there would not be too much difference in cargo space?

Mr. GODWIN. On the *Savannah*, I said that even with this first ship we could carry essentially the same amount of cargo that a conventional ship would carry.

Mr. GARMATZ. Can you carry more?

Mr. GODWIN. In a boiling water reactor tanker, we would carry more.

Mr. GARMATZ. I have one more question. You are talking about this material which is taken off after a certain length of time and rewashed. What happens to that material?

Mr. GODWIN. You are speaking of the fuel.

Mr. GARMATZ. Say it was unloaded at the port of Baltimore and taken out and reused. Where could that material stay? Must that go back to a particular port or can that stay anywhere?

Mr. GODWIN. Are you referring to the fuel or waste materials or both?

Mr. GARMATZ. The material that you said would be rewashed.

Mr. GODWIN. This was radioactive waste materials.

We continually purify the water in the primary system of the *Savannah*. We run it through filters and ion exchange beds.

Mr. GARMATZ. Can you use that again?

Mr. GODWIN. We can use the ion exchange beds. We have to backflush them. In backflushing them we run the material over to the service barge which collects the materials and the ship can proceed. If time is of the essence, we can remove a particular filter and replace it in a matter of a few hours.

If you are talking about the fuel, the fuel will last about 3 years, as we presently visualize it. The fuel will be removed from the ship to the beach. It will then be transported to a Commission facility, let us say Hanford, where the uranium 235 and plutonium are taken from these rods, which you see here, and reprocessed. We can then put the U 235 back into new elements. To answer the question specifically, this fuel is sent to a reprocessing facility which then, you might say, rejuvenates the fuel and sends it back to a nuclear ship.

Mr. GARMATZ. You get your supply from the base, then, not necessarily the particular material that was on the scow?

Mr. GODWIN. No; we are not dependent upon the barge.

The CHAIRMAN. Mr. Tollefson.

Mr. TOLLEFSON. I have just one or two questions.

Mr. McCone indicated yesterday, if I remember correctly, that the results of the testing, if that is the word, with the boiling water reactor

were surprising in that the reactor developed two or three times more power than was anticipated.

Mr. GODWIN. Yes.

Mr. TOLLEFSON. I merely asked that to preface another question. You people who are most familiar with atomic energy still cannot predict exactly what might happen in the next year or 2 years or any given period of time, can you?

Mr. GODWIN. I think we can predict. We have found in our experience that costs have generally been higher and performance has generally been better.

This sounds somewhat of a paradox but it is quite understandable.

When I say "capital costs," we have generally been driven into situations in which we build in a great degree of surety in terms of safety, instrumentation containment, shielding, and in many cases it has turned out to be not absolutely necessary.

We have been very conservative with what we think our materials can do. For instance how good is stainless steel? Do we have to go to zirconium or more exotic materials?

In the boiling water instance that Mr. McCone referred to, we designed for 20 megawatts, and it looks as if the plant will produce five times what the plant was designed to do.

So, in answer to your question, we can predict, and I think we have enough know-how to predict fairly closely, as to what a given powerplant will do.

Mr. TOLLEFSON. When we had the legislation before us authorizing the *Savannah*, somebody from the AEC, and I cannot remember who it was, in response to questioning indicated that if we were to progress we ought to get on with the project instead of putting it off, because it takes so much time to develop a project. For instance, the legislation for the *Savannah* was signed into law in July of 1956 and now, about June of 1959, 3 years later, we will have the ship.

If we are going to get on with this tanker program, it will likewise take a period of time. I would guess that you people who are interested in development would subscribe to a philosophy of getting on with projects so that we can get them accomplished, is that true?

Mr. GODWIN. I think that is true. The *Savannah*, of course, is an expedited program. This is as short as one can do it, shorter than any we have ever done. Even if we had authorization in this session and depending upon money, it would take us at least until 1963 or 1964 before we have a hull in the water.

Mr. TOLLEFSON. If we wait until next year to authorize it, it will be a year later.

Mr. GODWIN. That is correct. All projects, I should point out, are time dependent upon the reactor, not the hull. Where we are building reactors of advanced design the more development we do the better system we get but sooner or later you have to freeze on a design and we would do this in as short a period as we could.

The CHAIRMAN. You have cleared up one part of this budget message, quoting the President's budget message:

> **Research on improved nuclear propulsion of merchant ships is continuing.**

You cleared that up.

I will ask Mr. Morse this question because I think it is the responsibility of this committee to pay some attention to this budget message.

I tried to ascertain it yesterday, but I do not think that the answer was clear:

Legislation should be enacted to assure that nuclear materials may be distributed for use as fuel on U.S. merchant ships.

What ships was he talking about here. I grant you it is U.S. merchant ships. That is taking the whole fleet.

What does he mean? What legislation should be enacted?

Mr. MORSE. I think Mr. Godwin can answer that more accurately because that is directly in the field in which he has been working.

Mr. GODWIN. I think under the Atomic Energy Act, the legislation is not clear as to whether or not we can release uranium fuels for use outside our country's limits and this legislation, which the President's message addresses itself to, refers to clarification to permit us to in fact export uranium for use in merchant ships. It is clarifying legislation and, as to your question as to what ships it addresses itself to, I would say the ships which we hope to build in the future.

The CHAIRMAN. What kind of legislation should be enacted? Should this committee enact it or is it something for the Atomic Energy Committee?

Mr. GODWIN. As I understood it, it was legislation which was to clarify the Atomic Energy Act in this regard.

Mr. MILLER. Mr. Chairman.

The CHAIRMAN. Then why should any legislation be enacted if we are not going to authorize the construction of ships or the utilization of it by our own ships?

Mr. MORSE. I would assume this has reference to the possibility of exporting nuclear fuel for installation on ships if ships are built abroad.

The CHAIRMAN. Are we going to furnish the fuel for ships of other nations? Is that what it means?

Mr. MORSE. There is a prohibition, as I understand it, in the Atomic Energy Commission legislation at the present time which would prohibit the export of this fuel.

The CHAIRMAN. From what you just said, am I right in assuming that we are going to help other nations advance this art and not advance it ourselves?

Mr. MORSE. I would not care to comment on your assumptions, Mr. Bonner.

The CHAIRMAN. Well, it is a fair question to ask, is it not?

I will ask the reporter to read your answer.

(Record read by the reporter.)

Mr. GODWIN. I think that is correct. It is not clear whether we can export it, whether it is in our own ships or others.

Mr. MILLER. Mr. Chairman.

The CHAIRMAN. Just 1 minute.

If this Congress authorized an additional ship, do you think, Mr. Morse, that the President or the Bureau of the Budget would ask for money in due time for its construction?

Mr. MORSE. I am very hopeful that this Congress will enact authorizing legislation this year for a second atomic powered ship and we believe it should be a tanker. I am also very hopeful that this Congress will enact legislation which would permit a cooperative program

with industry in the development of nuclear powered ships. We need both of those things, in my opinion.

The CHAIRMAN. Now, you have answered the question that as the result of these hearings we should bring forth a bill authorizing an additional ship.

Mr. MORSE. I think I have answered your question.

The CHAIRMAN. Mr. Miller.

Mr. MILLER. My only question along the lines you were asking about the export of this material.

Under what authority, then, is the *Nautilus* or any of our atomic submarines permitted to go outside the continental United States with atomic energy on it?

Mr. GODWIN. I think the answer to that one is that the military in both the instances of military vehicles and in the nuclear weapons instance does have a special exemption under the Atomic Energy Act.

Mr. MILLER. You know that?

Mr. GODWIN. I do not know it for a fact.

Mr. MILLER. Is it not an assumption that this was military or is it not also an assumption that an American flagship subsidized or built by the Government in the interest of national defense incidentally is in the same position as a vessel of the Navy?

Mr. GODWIN. In some ways it certainly would be. Although I think, for atomic energy purposes, maritime propulsion is generally considered as a civilian pursuit as contrasted to the military.

Mr. MILLER. If we built such a ship, we would not only subsidize it but certainly defense features would be built into such a ship.

Mr. GODWIN. I think so; yes.

Mr. MILLER. Then in fact it becomes an auxiliary ship of the Navy subject to call by the Navy in time of war; is that right?

Mr. GODWIN. That is true; yes.

Mr. MILLER. Then it is not another little part of the curtain which it seems we are trying to hide behind and not trying to get on with the job?

Mr. GODWIN. In the course of studying the legislation for the *Savannah*, and this is the genesis, I believe, of this particular statement in the President's message, we were trying to clarify a number of legal problems. One problem which appeared to presently exist in the legislation was whether or not we had the authority to transport nuclear materials outside of the United States, and thus we needed clarifying legislation.

Mr. MILLER. If we got on with the job and built the ship, it would be 1962 or 1963 before we would actually need that authority to take it beyond because it would be in the process of building.

Mr. GODWIN. It would take us at least that time; yes.

Mr. MILLER. I just left another committee where we were discussing the Vanguard and had Dr. Hayden and Dr. Silverstein there and the question came up that they did not have certain solar batteries in it because at the time they designed this thing the solar batteries were not as far advanced as they are today and they were shooting at today.

If they had started a year ago, they would have had these solar batteries.

Would it not have been rather foolish if we wanted to put that thing in orbit if we waited to have it all perfected? Is that not the reason

that the Russians are ahead of us in that field and will they not get ahead of us in this field if we do not act rapidly?

Mr. GODWIN. Yes; I think you are right.

Mr. MILLER. Is that right, Mr. Morse?

Mr. MORSE. That is right, Mr. Miller. We are talking about authorizing legislation. When you talk about dollars we are not talking in that field.

Mr. MILLER. As far as you are concerned, would you make the effort to get the dollars?

Mr. MORSE. To the best of my ability, I would proceed with the program.

Mr. MILLER. Spoken like a good San Franciscan.

Thank you.

The CHAIRMAN. Mr. Morse, going further in this message, there is the statement:

> There should also be an examination of present policies on such matters as foreign flag registration and the competition of foreign shipping.

Connecting that with "legislation should be enacted to assure that nuclear material may be distributed for use as fuel on U.S. merchant ships," does that mean that it might be possible to build U.S. merchant ships abroad under this effective control policy with nuclear materials as propulsion or does it have any connection with this effective control?

Mr. MORSE. I do not think there is any connection, Mr. Bonner.

The CHAIRMAN. What U.S. merchant ships are we talking about in this budget message? Are we talking about ships that fly the American flag or just owned by U.S. citizens?

Mr. MORSE. Utilization of the nuclear fuel, I am sure has reference only to American flag vessels.

The CHAIRMAN. Mr. Dorn.

Mr. DORN. What I do not get clearly is after the *Savannah* is in operation, what lines will it compete with, what cargoes will it compete with on what lines and how will it take on cargoes from what places to what places and who is going to decide?

Mr. MORSE. When it is in operation, there will be a period of 6 months to a year even when it will be tested only.

After the experimental test period has been terminated, then the vessel will go to various American ports so that the American citizens can see what this vessel is, what progress has been made in nuclear propulsion.

I think the contemplation is also that the vessel will go to some foreign ports to indicate the development we have made in peaceful use of atomic power.

Mr. DORN. Completely under the direction of the Maritime Administration?

Mr. MORSE. Yes, sir.

Mr. DORN. Well, the time has come then when this ship has gone to an enormous number of ports. I take it it has gone to these ports without passengers and cargo.

Mr. MORSE. No, after the trial period we would assume that we would carry some cargo and passengers.

Mr. DORN. What I am getting at is in carrying this cargo and in carrying these passengers, have you decided with what shipping lanes you will run in competition?

The CHAIRMAN. Let me interrupt you there, if you will.

We went through this in the assignment of the *Savannah*. At that time it was generally stated and I understood that the *Savannah* would from time to time be assigned to different companies operating on certain trade routes? Is that the general policy that will be carried out? That is what you want to know?

Mr. DORN. That is what I am trying to find out.

The CHAIRMAN. That was the understanding, was it, Mr. Morse?

Mr. DORN. That it will be assigned to various shipping operators?

Mr. MORSE. That is not my understanding of what I previously said to you. My understanding is that we would appoint a general agent for the vessel and, when the vessel went to the United Kingdom, for example, the United States Lines would service it and when the vessel went to the Mediterranean, it would be American Export.

Mr. DORN. So that we would not be operating in competition with our own. We would be operating in conjunction with our own?

Mr. MORSE. We are not planning to operate this vessel by the Government in competition with private lines.

The CHAIRMAN. You mean that when it went on the trade route of the United States Lines they would supervise the passenger list and the freight and accordingly other lines? That is what I understood, and I understood that the vessel would carry the insignia of that line when they were on that trade route. That is what I understood. I do not want to get back into the assignment again. We have gone over that.

We are interested in what we should do now for the future.

Proceed.

Mr. DORN. That is all.

The CHAIRMAN. Mrs. Sullivan.

Mrs. SULLIVAN. I have no questions.

The CHAIRMAN. Mr. Pelly.

Mr. PELLY. Mr. Chairman, I would like to mention that Mr. Godwin certainly shows that Washington State University training has made a wonderful product. I am very proud of him.

The CHAIRMAN. I think I made myself clear when I said I did not presume to have the ability to ask any further questions. It was most interesting.

Mr. Ashley?

Mr. ASHLEY. I have no questions.

The CHAIRMAN. Mr. Lennon?

Mr. LENNON. I have no questions.

The CHAIRMAN. Mr. Nix?

Mr. NIX. I have no questions.

The CHAIRMAN. Mr. Oliver?

Mr. OLIVER. I have no questions.

The CHAIRMAN. Mr. Hoffman?

Mr. HOFFMAN. If the most freshman of the freshmen congressmen may ask a question.

The CHAIRMAN. Go right ahead.

Mr. HOFFMAN. There are two things confusing me. I understand from discussions here that we do not have legislation that will allow us to take nuclear material out of the United States. Now, I would

assume, Mr. Chairman, that that would be one of the things we would have to do before we could even go any further.

The CHAIRMAN. I do not think that would come under the jurisdiction of this committee. I think that would be the Atomic Energy Committee.

Mr. HOFFMAN. The second thing I am a little confused on is that on page 10, in Mr. Morse's statement, he says they would build the *Savannah* and "enough experience would be gained in the actual construction, operation" to "realistically design a second ship which could approach an acceptable status." Then in the next paragraph you say, in effect, "let us build one."

Mr. MORSE. Timewise, let us talk about that. I would assume if we were fortunate enough to get authorization for a second ship we would not get any money this year so we would assume that the earliest we would get money would be July 1960. It would take us a good year to finalize the plans and specifications and negotiate a contract for the building of the reactor on the ship so that that is July 1961.

It took 39 months to build the reactor on the *Savannah* and on a more or less crash basis, so we are then up to the fall of 1964.

Now, by July, 1961, the *Savannah* will have been in operation for nearly a year and a half so we will have had much experience in the actual operation of the *Savannah*.

Mr. HOFFMAN. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Downing.

Mr. DOWNING. Thank you, Mr. Chairman, I have two questions.

Obviously from what you have stated here, safety is still an important factor in nuclear propulsion. Maybe the rest of the committee knows, but I do not know.

Could you describe what the potential danger is in the event there was a collision, say, in the harbor?

Mr. GODWIN. Well, it boils down to a number of assumptions but we have studied a great number of accidents. We assume the maximum credible accident is one in which we lose all the primary water in the reactor system, in other words, all the cooling water is lost. Under those conditions the containment vessel would contain all of these materials. Thus radioactive materials would not escape from the ship. That is an internal accident.

Take an external accident where, let us say, a ship operating in New York or any other port collided with the *Savannah*. Two cases exist: (1) It hits in the reactor area, or (2) it hits something somewhere else. Let us take the case of hitting the reactor area.

The design of the *Savannah* is such that approximately 98 percent of the world's ships, excluding the very largest, the *Queen Mary* and ships of that type, operating at essentially full speed, or large tankers with high kinetic energy impacts, all ships except those largest operating at full speeds could not penetrate the *Savannah* to the containment vessel. This is assuming a good clean inelastic collision.

Take the other case where you consider one of these larger ships impacting in the *Savannah* going full speed. Since in ports and harbors they do not operate in that manner we assume that there is no

collision situation in a harbor where a collision could in fact render the reactor unsafe.

Mr. DOWNING. Suppose it did.

Mr. GODWIN. In that case, you have to assume a point of contact. Let us assume that it was impacted at full speed, which would have to be out on the open seas, and it struck in the reactor area. There is always the chance that it could shift the containment vessel, which would shift as a total. We believe it would shift as a unit rather than breach. It is approximately 2½ inches of steel inside of a 3- to 4-foot band of concrete inside of a heavily reinforced hull.

The thing would shift off its axis and under those conditions the reactor would be rendered inoperable but it would not, from any studies we have made, be breached. So if you can make the assumption that the *Savannah* could be struck severely enough to sink, it would have to be in open water. We do not think a situation could develop where the ship could be sunk in confined waters. You get to the simple problem of what would happen with a reactor at the bottom of the ocean. It comes down to the fact that there is probably no safer place than at the bottom of the ocean. Bearing in mind that the reactor is encased in a steel containment vessel and the radioactive fission products are then encased in stainless steel rods. It would probably be many, many years before this material would be exposed.

Mr. DOWNING. Thank you. I have one more question of Mr. Morse, if I may.

Mr. MORSE. I have a copy of the paper called the "Seafarers Log," dated February 13, 1959, in which the headlines read: "Germans Set To Build First Atom Tanker," and reading the article, it appears that they expect to have a 10,000 horsepower nuclear reactor in a tanker by 1964 and that the completed contracts indicate that the project will cost from $3.6 million to $4.8 million.

Are you familiar with that?

Mr. MORSE. I have seen that article, but I am not familiar with the dealings. I think Mr. Godwin is familiar with the particular problem that you are discussing.

Mr. DOWNING. Is that true, Mr. Godwin?

Mr. GODWIN. You mean the price?

Mr. DOWNING. Are they going to build a tanker?

Mr. GODWIN. I am not familiar with the details. As I understand it, the situation is one in which the Germans have entered into an arrangement with a U.S. company to undertake design studies and some development aimed at building a tanker, and I gather the tanker would be built if this design and development work turned out to be as fruitful as they hope. This is only my personal opinion. I do not think there is any arrangement made to construct such a vessel, in other words, no set time when the construction would start. This is as I understand it. It should be pointed out that the work they are planning to do with this company takes up where we terminated. This company has performed work for us in the Atomic Energy Commission and the Maritime Administration. We did not have enough funds to continue. This is being taken from that point on by the Germans.

Mr. DOWNING. The article states they expect it will cost from $3.6 million to $4.8 million.

How do you compare those costs with ours?

Mr. GODWIN. There is nothing wrong with the figures.

It depends upon what they define as a reactor. We have been talking here today about programs, not hardware. There is a very neat distinction on this point upon which we very often have misunderstandings. People talk about the *Savannah* as costing $41 million. This is true if you talk about the total program, training crews and building shore facilities, but the hardware is going to cost only in the order of $31 million.

In this instance, I suspect what they are talking about is the reactor or primary system only but not necessarily the total program or propulsion system unless they know a lot more about it than we do.

Mr. DOWNING. Does this point up the need for us to move ahead in this direction?

Mr. GODWIN. We consider the organic system as a very attractive system. We, through limitation of funds, have not been able to pursue the organic work as we would desire.

We have brought design studies only to a point where we could determine what kind of powerplant could be installed in a ship now without a significant amount of development work. It was a close race between the boiling-water reactor and the organic system that the Germans are talking about. We selected the boiling water, but this in no way should reflect upon the virtues of the organic cooled and moderated reactor.

The answer is that there are a number of good systems we should keep an eye on. It looks as if we cannot keep an eye on them all however.

Mr. DOWNING. The article says that:

> Plans for the German vessel call for using a low-pressure reactor that would be able to operate within the economical limits necessary to private business.

Are they ahead of us in that regard?

Mr. GODWIN. It depends on how you look at it. The work on the reactor is probably going to be done by an American firm. They might be ahead of us if they build a ship first.

Mr. LENNON. Would the gentleman yield?

Mr. DOWNING. Yes.

Mr. LENNON. Did I understand you to say that this American company moved in essentially where you folks left off because you had to discontinue because of lack of funds?

I heard Mr. McCone say yesterday that the Budget Bureau was very liberal for fiscal 1960 and gave them everything that they asked for.

I wonder how you reconcile that statement with your statement.

Mr. GODWIN. I think they are reconcilable. We who are enthusiastic aim at a broad program. The agency got all it asked for, but we on the working levels, being possibly more enthusiastic, requested more than we were allotted within the agency.

Mr. LENNON. What program did you abandon for lack of funds which has been taken up now by this American concern?

Mr. GODWIN. In 1956, the Maritime Administration and Atomic Energy Commission undertook a series of studies to determine what kinds of systems could be best applied to the merchant marine. The results of these studies showed a number of interesting things, (1) the boiling water reactor had the best chance for early application;

(2) the organic system at that time was not as advanced as the boiling water, as only one small experiment was planned for operation, and looked very promising, but we did not have the developmental backup to support the conclusions to put it into a ship.

Those two systems were very attractive to us.

The other conclusion from these studies was that the gas-cooled reactor had the long-range potential. What we did with the funds we had was to concentrate on the boiling water system as contrasted to the organic simply because there was quite a bit of development that had to be done on the organic system.

Mr. McCone stated, the civilian power program is pursuing the organic system and a lot of work has been done. We have been more or less in the position of monitoring what is going on in other programs and hoping that they will break out enough information for us to use. Atomics International, a division of North American Aviation, who did the work for us, is the firm I think referred to in that article that you point out here. The work they did for us was terminated in 1957. These studies have been presented to Germans, and they feel there is a great deal of potential, but this is also based upon work done in the intervening period. There is a lot of work going on in other programs of the Commission.

Mr. LENNON. The gentleman will excuse me for breaking in.

Mr. DOWNING. I have nothing further, Mr. Chairman, except to suggest that maybe this article should be placed in the record.

The CHAIRMAN. It may be placed in the record.

(The article referred to follows:)

[From the Seafarers Log, vol. XXI, No. 4, Feb. 13, 1959]

GERMANS SET TO BUILD FIRST ATOM TANKER

HAMBURG.—A West German concern plans to have the first truly commercial atom-powered ship in service by 1964. The vessel will be a tanker powered by a 10,000-horsepower nuclear reactor.

Completed contracts indicate the project will cost from $3.6 million to $4.8 million or roughly one-tenth the cost of the prototype commercial atom ship now being constructed in the United States. The U.S.-flag *Savannah* is due to be launched next year at a cost of $42 million. She will be a 22,000-ton combination cargo-passenger ship with accommodations for 60 passengers. The *Savannah* is not being built with an eye toward commercial operation, but purely as an experimental vessel, and no effort was made to keep cost in line with conventional ships.

Plans for the German vessel call for using a low-pressure reactor that would be able to operate within the economical limits necessary to private business. This would contrast with the high-pressure reactors used in the U.S. Navy's atom subs. The Savannah will be powered by a reactor similiar to the one aboard the pioneer U.S. atom sub *Nautilus*.

Critics of the U.S. atom ship program have questioned the large Government expenditure on a ship that will admittedly not be suitable for commercial operation, and will not even be powered by an advanced type of reactor. More efficient types of reactors have been utilized on the newer atomic subs built for the Navy since the *Nautilus* went into operation in 1955.

The proponents of the program have argued that the prototype ship by its very experimental nature, will pave the way for rapid advances in nuclear power, which will give the United States an edge. They argue that it would not be wise at this early stage of nuclear power development to "freeze" a design and possibly wind up with an outmoded fleet.

One estimate is that the *Savannah* will cost two and a half times as much as a conventionally powered ship of the same size built in the United States. The low price tag on the West German ship is partially due to the fact that costs in West German shipyards are among the lowest in the world.

It is believed the German ship will eventually pay its own way since the experts are generally agreed that tankers are more suited to atom propulsion than dry-cargo ships.

Mr. GARMATZ. Would it be necessary for Germany to obtain the necessary fuel from the United States to put that ship into operation?

Mr. GODWIN. I think so; yes. I do not know of the enrichment involved, but it is somewhat enriched, something around 3 percent 235. They would necessarily have to come to the United States or the United Kingdom to get the material. I would say the United States.

The CHAIRMAN. The distribution of material is not under the foreign aid program, is it?

Mr. GODWIN. I think that the Germans might also look to the international agency to which the United States has earmarked some material, which we spoke about yesterday. They would have a number of pools to draw this uranium from. Which one they would avail themselves of, I just do not know.

The CHAIRMAN. Mr. Flynn.

Mr. FLYNN. I have no questions.

The CHAIRMAN. Mr. Johnson.

Mr. JOHNSON. Mr. Chairman, I have one question.

Mr. Godwin, we had testimony presented yesterday that the Navy in its program has and is developing this nuclear propulsion in their ships.

It was stated that they have an aircraft carrier and I think also the submarine and even cruisers. Is there any duplication of technical knowledge between their program dealing with nuclear propulsion and the program underway here with the NS *Savannah?*

Mr. GODWIN. I would say there was no duplication. I would say that we have leaned heavily on the technology developed in the Navy program, and we still do. Their program being significantly larger than the one we are talking about here; but it should be recognized that their incentives and motivations are significantly different than ours.

We have a commercial incentive and can live with some situations that the Navy cannot live with. We are looking for simplicity and are willing to sacrifice full-time operation.

We can lose reactor power for a period of time which is just unacceptable to the Navy.

The Navy requirements in terms of G loadings and conditions of operation are a lot more severe than the ones we have, but in the final analysis the difference boils down to economics.

We have to have a plant that will eventually operate competitively with conventional power and from that standpoint we have a divergent program.

Mr. JOHNSON. So that you have no suggestion as to the two programs being better coordinated?

Mr. GODWIN. No; I think the work the Navy is doing in the Atomic Energy Commission and the work the Maritime is doing in the Atomic Energy Commission are coordinated. The work under Admiral Rickover and myself are carried out under similar arrangements. We work in the same organization and our exchange of information is very broad.

The CHAIRMAN. Counsel?

Mr. DREWRY. Mr. Godwin, I would like to clear up something at least in my own mind. Yesterday there was quite a lot of emphasis placed on the economics in the *Savannah* plant and the one projected for the tanker and the fact that neither the *Savannah* nor the next one will be economical. Of the plants in being and in operation and those presently in planning stage, are any of them economical?

Mr. GODWIN. You mean central-station powerplants. To my knowledge, none of the plants designed, building, or planned to be built in the near future will be economical.

Mr. DREWRY. So there is not any difference in the marine application and the land application as far as the actual economical return from the operation of the unit?

Mr. GODWIN. That is true. In central-station powerplants, as Mr. McCone stated, they hope to obtain economic operation within the next decade. We do not believe we have anything on the board which is going to get there the first time out.

Mr. DREWRY. They are going ahead nevertheless and building new ones as experience is gained with each project?

Mr. GODWIN. That is correct.

Mr. DREWRY. That is all.

The CHAIRMAN. If there are no further questions, the committee will stand adjourned, and I want to thank you, Mr. Morse.

(Whereupon at 12:25 p.m., the committee adjourned, subject to the call of the Chair.)

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